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E SURGICAL TREATMENT

OF

INTESTINAL OBSTRUCTION.

BY

N. SENN, M.D., Ph.D., Milwaukee, Wis.,

Attending Surgeon to the Milwaukee Hospital; Professor of the Principles of Surgery and Surgical Pathology in Rush Medical College, Chicago, Ill.

Paper read before the Congress of American Physicians and Surgeons, Washington, D. C., September 19th, 1888.

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THE SURGICAL TREATMENT OF INTESTINAL OBSTRUCTION.

BY N. SENN, M.D., PH.D., MILWAUKEE, WIS.

Attending Surgeon to the Milwaukee Hospital; Professor of the Principles of Surgery and Surgical Pathology in Rush Medical College, Chicago, Ill.

THE operative treatment of intestinal obstruction is in its infancy. Since laparotomy for other indications has became an established and frequently practised procedure, a number of the bolder and more aggressive surgeons have resorted to direct measures for the relief of intestinal obstruction, but like all serious operations for otherwise incurable and fatal affections its general application has met with strong opposition not only by the laity, but also by the profession. The appalling mortality which has attended the operations in the hands of even the most competent surgeons has been quoted in the discussions of this subject in medical societies as a sufficiently strong argument in favor of non-operative interference. In this regard the history of laparotomy for intestinal obstruction is only a repetition of the history of ovariotomy. During the early part of the latter, the mortality was so great that the operation was condemned and denounced as a deliberate murder by some of the ablest and most influential surgeons. Men who had the moral courage to perform ovariotomy in the face of such bitter opposition only too often reaped a harvest of reproach for having performed their duty towards their patients. Yet in spite of all opposition the good work progressed until by an improved technique, and more especially by the introduction of antiseptic surgery, ovariotomy in the hands of experts has become one of the safest operations in surgery. To accomplish this, hundreds of lives were sacrificed that thousands might be saved. The early ovariotomists operated only on patients worn out by the disease and often the subjects of additional serious visceral lesions caused by the prolonged intra-abdominal pressure, the reason for this being the great mortality which attended the operation. To-day the danger incident to opening the abdominal cavity under proper antiseptic precautions is so slight that patients suffering from ovarian tumors are encouraged to

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have them removed as soon as their presence can be diagnosticated, at a time when the general health remains unimpaired, a change of practice which has still further reduced the mortality of ovariotomy. The mortality of laparotomy for acute intestinal obstruction will be reduced to that of other intraperitoneal operations, as soon as surgeons will recognize the importance of operating early before the patient's strength has been wasted by the disease, and before the parts involved in the operation have undergone irreparable textural changes. The mortality of abdominal section in the treatment of the different forms of intestinal obstruction will always be great, because the conditions which have caused the obstruction are often an intrinsic source of danger. In others the removal of the obstruction necessitates an intestinal resection which in itself is a vastly more serious operation than the removal of an ovarian tumor. Intestinal obstruction, irrespective of its cause, is always followed by a series of consecutive pathological changes which, independently of the partial, or, complete interruption of the passage of intestinal contents, tend to destroy life. The dilatation of the intestinal tube on the proximal side of the seat of obstruction may give rise to such a degree of abdominal distension as to destroy life from suspension of important function by mechanical pressure. In acute obstruction, the violent peristalsis on the proximal side of the occlusion causes an increased afflux of blood to the portion of bowel the seat of exaggerated physiological function, which after cessation of peristaltic action remains as an intense venous and capillary engorgement. During the paretic stage the blood vessels in the intestinal wall have lost their extra-vascular support, hence transudation and exudation readily take place into the paravascular tissues, which, combined with the capillary stasis attending this stage of the inflammatory process, often results in gangrene. The intestinal wall, in a state of inflammation, becomes permeable to pathogenic microörganisms which are always present in the intestinal canal, and which after passing through the entire thickness of its walls enter the peritoneal cavity and induce septic peritonitis — a frequent immediate cause of death. These facts are cogent reasons for adopting surgical measures in all cases of intestinal obstruction due to mechanical causes as soon as a probable diagnosis can be made. If this were done, the two greatest sources of immediate danger attending and following laparotomy, shock and septic peritonitis, if not entirely avoided, at least would be less likely to occur, and the tissues the seat of operation would be in a favorable condition for direct treatment and repair. An abdominal section in the treatment of intestinal obstruction is always necessarily attended by some shock,

and it is therefore of the utmost importance to perform the operation at a time when the organs of circulation and the nervous system are still in a condition to successfully resist the immediate effects of the operation. Death from septic causes can only be avoided by operating at a time when the intestinal canal at the seat of obstruction and on its proximal side is still in a condition capable of resisting infection and of undergoing a satisfactory process of repair in case it becomes necessary to incise, or resect during the operation. The statistics of operations for intestinal obstruction will improve as soon as we shall be able by improved methods of diagnosis to make an early positive diagnosis and to adopt in the treatment positive surgical measures before the prospects of a recovery have been rendered improbable, if not impossible, by days and weeks of useless, and worse than useless, internal medication. True intestinal obstruction, whatever its cause may be, is as strictly a surgical affection as strangulated hernia and remediable only by the same kind of surgical treatment. Physicians should recognize this fact and should call into counsel a surgeon as soon as a probable diagnosis of intestinal obstruction can be made. To let a patient die of the consequences of a removable cause of obstruction without an operation is a reflection upon the advances of modern aggressive surgery. The difficulties which surround the diagnosis and the present imperfect technique of the operative procedures in cases of intestinal obstruction are not only responsible for the heretofore late operations, but also to a great extent for the many failures. Ways and means for more accurate diagnosis will have to be devised by more careful clinical observations and by experimental research; while new and improved methods of operation must be devised and their merits and safety tested by experiments on animals. I am convinced that accurate experimental work of this kind will render essential information in the diagnosis of the obscure causes of obstruction, and will point out more clearly the indications for operative treatment, while improved methods of operation will have to be studied exclusively in this manner. The obstacles which the surgeon encounters in the diagnosis and treatment of many cases of intestinal obstruction often appear insurmountable, but they will be greatly diminished in the future by facts which will be revealed by the results of experimental investigation. Abdominal surgery was founded and developed on American soil, and in the part which refers to the treatment of intestinal obstruction ample scope is left for the exercise of the genius and perseverance of the younger members of the profession in this country, who would do honor to the memory of our McDowell, our Sims, and our Gross by honest, faithful, unselfish original work.

I. Definition of Intestinal Obstruction.

Intestinal obstruction, occlusion and strangulation have been used as synonymous terms. Some authors wish to draw a line of distinction between cases of intestinal obstruction and intestinal strangulation, including under the former term all cases where the obstruction is caused by a tumor, enterolith, or intussusception, while internal hernia, volvulus, and constriction by a band were included under the head of strangulation. For practical purposes such a distinction is superfluous, as any cause which mechanically interferes with the passage of intestinal contents produces intestinal obstruction, and if it cannot be removed by ordinary means should be treated by abdominal section. The classification into true and false obstruction, from a surgical standpoint, should also be abandoned as operative interference is only indicated in cases of obstruction due to the presence of mechanical obstacles, such as foreign bodies, tumors, or intussusception in the lumen of the bowel, or to compression of the lumen by tumors, flexion, twisting, and bands of constriction. Inflammation of the tunics of the bowel and diffuse peritonitis may give rise to symptoms resembling obstruction, but in such cases the obstruction follows as a sequence of an antecedent, or accompanying inflammatory lesion, and is due to dynamic disturbances and not to mechanical occlusion, and the indications for treatment are to combat the inflammation and to restore peristaltic action, combined with mechanical means to relieve the abdominal distension. A more important classification remains to be mentioned by which all cases of true intestinal obstruction are divided into acute and chronic. This distinction must be maintained for many reasons. In chronic obstruction the symptoms usually develop very slowly as the occlusion becomes more complete. During the early part of the affection the intestinal walls above the seat of obstruction undergo compensatory hypertrophy, dilatation taking place very slowly unless the chronic suddenly merges into the acute form, an event which is always announced by a complexus of symptoms characteristic of acute or subacute obstruction. Chronic obstruction is more frequently met with in persons advanced in years and the seat of obstruction is usually located in some part of the large intestine. The acute form is caused by some pathological conditions which suddenly narrow, or obliterate the lumen of some portion of the intestine, usually above the ileo-caecal valve, and often without any premonitory symptoms gives rise to a complexus of acute symptoms almost pathognomonic of this affection. The sudden interruption of the passage of intestinal contents is followed by violent

peristaltic action of the bowel above the seat of obstruction in a vain attempt to clear the intestinal tract, which from muscular exhaustion and the distension from the accumulation of intestinal contents finally gives rise to paresis and the textural changes previously alluded to. In such acute cases prompt action constitutes an essential element of success, as in a few hours or days, the patient becomes utterly prostrated and the bowel at and above the seat of obstruction has undergone irreparable pathological changes. These are the cases that demand early surgical treatment and will claim our special attention in the discussion assigned for this evening.

II. Frequency of Intestinal Obstruction.

An examination of the statistics of Leichtenstern* shows that, external herniæ and malignant tumors being excluded, one death from intestinal obstruction takes place in every three to five hundred deaths from all causes in hospital practice. This statement is based upon the records of the late Dr. Brinton, of London, and a number of large hospitals on the European continent.

Hilton Fagge† has shown from an examination of the records of four thousand autopsies in Guy's Hospital, from 1854 to 1868, that fifty-four, or about one-fourth of one per cent., were cases of intestinal obstruction.

Heusner‡ from his own investigations regarding the frequency of intestinal obstruction maintains that annually out of every one hundred thousand individuals from five to ten suffer from this affection, and that one to every three to five hundred deaths is attributable to this cause. These statistics show the importance of intestinal obstruction in its medical and surgical relations, and it is eminently proper that this subject should have been selected for discussion at this time and on this occasion, that by interchange of thought and experiences new light be shed upon a class of affections which heretofore, only too often, have baffled the skill of both physician and surgeon.

III. Surgical Resources in the Treatment of Intestinal Obstruction.

1. *Irrigation of Stomach.*

The accumulation of intestinal contents above the seat of obstruction acts deleteriously in several ways: 1. It causes violent peristaltic action of the intestine above the seat of obstruction. 2. It ex-

* Ziemssen's Cyclopedia of the Practice of Medicine, American Translation, vol. viii.

† Guy's Hospital Reports, 1869.

‡ Deutsche Med. Wochenschrift, 1887.

hausts the patient's strength by causing persistent retching and vomiting. 3. It is one of the causes which produces distension of the intestine. 4. It favors fermentative and putrefactive changes in the intestine by the fluid serving the purpose of a nutrient medium for pathogenic microörganisms. In my experiments on animals where I made complete obstruction I never witnessed such persistent vomiting as in man. I attributed this difference to the fact that animals thus treated refuse, as a rule, both food and drink, and that the intestinal canal in proportion to the size of the abdominal cavity is much shorter than in man. Patients suffering from acute intestinal obstruction should abstain from taking either food or drink, as digestion and absorption are almost, if not completely, suspended, and the accumulation of fluids cannot fail in aggravating the symptoms.

Kussmaul* has introduced a new and exceedingly valuable therapeutic measure in the treatment of intestinal obstruction in the use of the elastic stomach-tube. By the siphon action of the tube, gas and fluid contents of the stomach and upper portion of the intestinal canal are evacuated, and thus abdominal distension is relieved and the hydrostatic pressure in the intestine above the obstruction diminished. He claims for this measure the following advantages: 1. Intra-abdominal tension is diminished and thus the first condition secured for the correction of the mechanical difficulties which have caused the obstruction. 2. It relieves the distension of the bowel above the seat of obstruction and consequently also the pressure of the intestines against each other, a condition which cannot fail to impair peristaltic action. 3. Finally, what is most important, by evacuating the accumulated contents it diminishes the violent peristalsis. He reports the case of an adult where an intestinal obstruction, due to an invagination had lasted twenty-three days, and which yielded to daily irrigations of the stomach. A portion of the intussusceptum sloughed and was found in the stool. The patient died later of peritonitis which may have started from the seat of invagination.

Bardeleben† in a paper on the treatment of acute intestinal obstruction praises the utility of irrigation of the stomach as a palliative means, but speaks at the same time of the danger incident to the employment of such a temporizing measure, as too much valuable time may be lost before a curative treatment is adopted. He reports a case in which irrigation afforded such absolute relief that the operation was postponed until it could be no longer of any avail. Kuester expects from irrigation of the stomach prompt palliative effects, but warns not

* Berl. Klin. Wochenschrift, 1884, Nos. 42, 43.

† Ueber Ileus. Berl. Klin. Wochenschrift, 1885, Nos. 25, 26.

to persist with it in cases where the seat and cause of the obstruction can be ascertained. Hahn looks upon it as a curative agent only in cases where the obstruction is due to koprostasis in the large intestine, and he claims that in such cases irrigation of the rectum would lead more promptly to the desired result.

Schlegtendal* claims that lavage of the stomach in the treatment of intestinal obstruction fulfills a threefold therapeutic indication: 1. It prevents distressing symptoms, 2. alleviates them when they are present, and in some cases, 3. cures the disease.

Rehn† maintains that irrigation of the stomach, as devised by Kussmaul, in the treatment of intestinal obstruction not only empties the stomach of its contents, but it also evacuates a certain portion of the intestinal canal above the seat of obstruction. In two cases of intestinal obstruction, where this expedient was resorted to after the abdominal cavity was opened, he observed that a considerable portion of the dilated intestine was emptied of its contents.

Heusner states that by this means many litres of intestinal contents can be removed, pain is relieved, eructation and vomiting controlled, peristalsis quieted, the function of the stomach restored, suitable nourishment can be taken and assimilated, thus maintaining strength and life until the cause of obstruction is removed spontaneously, or through the intervention of surgery. Madelung has called attention to the necessity of resorting to irrigation of the stomach prior to the administration of an anæsthetic in operations for intestinal obstruction, as without such precaution there is danger during the attacks of vomiting which are almost sure to be provoked by the anæsthetic, of fluid entering the trachea, causing suffocation, or later, pneumonia.

As an aid in the treatment of intestinal obstruction due to mechanical causes irrigation of the stomach should always be systematically practised every four to six hours, but as a curative measure it should never be relied upon. In my own practice I have always combined emptying of the stomach with irrigation, using large quantities of warm water rendered antiseptic by the addition of salicylated soda, or hypophosphite of soda. The washing out of the stomach, with a harmless and efficient antiseptic solution, has a decided beneficial effect in preventing fermentative and putrefactive changes in the intestinal contents above the seat of obstruction.

2. *Distension of Colon with Fluids.*

Evacuation of the colon by copious rectal injections is resorted to almost instinctively in every case of intestinal obstruction. This pro-

† Fortschritte der Medicin, 1887.

* Frauenarzt, 1887.

cedure has also been employed with the intention of utilizing the hydrostatic pressure as a means for the correction of the mechanical difficulties which have given rise to the obstruction. This method of treatment has given rise to the much discussed question as to the permeability of the ileo-cæcal valve to rectal injections of fluids, or to the insufflation of air or gases. The majority of those who have studied this subject clinically or by experiment, make the positive assertion that the ileo-cæcal valve is perfectly competent, and effectually guards the ileum against the entrance of both fluids and gases forced into the rectum, while others insist that it is permeable only in exceptional cases, and only a few claim that its resistance can be overcome by a moderate degree of pressure.

Heschl* made a number of experiments on the cadaver and satisfied himself that the ileo-cæcal valve serves as a safe and perfect barrier against the entrance of fluids from below. In testing the resisting capacity of the coats of the intestine he found that the serous coat of the colon gave way first to over-distension, while the remaining tunics yielded subsequently to a somewhat slighter pressure. The small intestine of a child on being subjected to over-distension ruptured first on the mesenteric side, the place where acquired diverticula are found.

Bull† has found that in the adult one litre of water injected by the rectum will reach the cæcum, but that the entire capacity of the large intestine is from four to five litres. He is of the opinion that in the living body fluid cannot be forced beyond the ileo-cæcal valve, although ancient and modern experimenters claim to have succeeded in the cadaver. He affirms that when the rectum is distended by air the ileo-cæcal valve is rendered incompetent and the air passes into the small intestines.

Cantani‡ is a firm believer in the permeability of the ileo-cæcal valve to fluid rectal injections. In one instance he treated a case of koprostasis by an injection of a litre and a half of oil per rectum, and an hour later a part of the oil was ejected by vomiting. He advises that the intestinal tract above the ileo-cæcal valve should be utilized as an absorbing surface in cases requiring rectal alimentation, and when in a diseased condition should be treated by topical applications.

Behrens§ concluded from his experiments that it required the insufflation per rectum of one and one-eighth litre of air to reach the ileum

* Zur Mechanik der Diastaltischen Darm-perforationen. Wiener Med. Wochenschrift, 1881, No. 1.

† Virchow u. Hirsch's Jahresbericht, 1870, B. 2, p. 180.

‡ Virchow u. Hirsch's Jahresbericht, 1879, B. 2, p. 180.

§ Ueber den Werth der künstlichen Auftreibung des Dickdarmes mit Gasen u. Flüssigkeiten. Dissertation. Goettingen, 1886.

through the ileo-cæcal valve. In his experiments he had no difficulty in overcoming the competency of the ileo-cæcal valve by rectal insufflation of air.

Debierré* made numerous experiments on the cadaver to test the permeability of the ileo-cæcal valve to rectal injections of fluids or insufflation of air. The results which he obtained were not constant. In some subjects the valve proved only permeable to air ; in others, to both air and water, while in some no air, or fluids could be forced into the ileum by any degree of force. When the intestine was left *in situ* the valve was found less permeable than when it had been removed from the body. He attributes the different degrees of competency of the valve to variations in the anatomical construction of the valve. If both lips of the valve are equal in length, or if the lower lip is longer, the valve was found impermeable. It proved permeable in cases where the lower lip was shorter, contracted and smaller than the upper. In the last instance the advancing volume of fluid, or air, lifted the upper valve, while in the former structure of the valve the margins of the lips of the valve were approximated, perfectly shutting off all communication between the colon and the ileum.

Mr. Lucas† enumerates the following objections against forcible rectal injections of water as a means to reduce an invagination :

1. Owing to its weight, it exerts much too strong lateral pressure for the intestine safely to bear, and he has found it easy to rupture the bowel after death by forcing in water.

2. Should reduction have been accomplished the contact of a large quantity of water with the large bowel is apt to increase the tendency to diarrhœa. He claims very properly, that gas, on the other hand, is a natural occupant of the intestinal canal, and whilst its pressure is of the gentlest, its presence excites no unnatural peristaltic action. He administers an anæsthetic to the point of relaxation before the inflation is attempted.

Dawson‡ made a number of experiments on the cadaver, and came to the conclusion that when the ileo-cæcal valve is in a normal condition, it effectually guards the small intestine against the ingress of fluids from below.

Illoway§ devised a force-pump which he strongly recommends for

* La valvule de Bauhin consideré comme barriere des apothicaries. Lyon Medicale, 1885, No. 45.

† On Inversion with Inflation in the Cure of Intussusception. The Lancet. Jan. 16, 1886.

‡ Lancet and Clinic. 1885, Feb. 21.

§ American Journal of Medical Sciences. Vol. xli., p. 168.

the purpose of forcing water beyond the ileo-cæcal valve in case the seat of intestinal obstruction is located above that point. He reports four cases of intestinal obstruction treated by this method, three of which recovered.

Battey* asserts the permeability of the entire alimentary canal by enemata, and verifies his statement by the recital of his own clinical experience and experiments upon the cadaver. Ziemssen recommends inflation of the rectum for diagnostic and therapeutic purposes and proceeds as follows: A rectal tube about six inches long is carried into the anus and fixed by pressing together the nates, the patient lying on the back. A funnel is then connected with the rectal tube by means of rubber tubing. For complete inflation of the large intestine three drachms of bicarbonate of soda, and four and one-half drachms of tartaric acid are separately dissolved in water and portions of other solutions alternately added. To prevent sudden over-distension of the bowel it is advised to add the solutions at intervals of several minutes. A very important use of this method is to diagnosticate the position of the contractions, strictures, or occlusion of the intestine in cases in which it is desirable to operate, and also as showing the position of peritoneal adhesions. The result of his observations has led him to believe that, as a rule, the small intestine is completely closed to the entrance of substances from the colon by the ileo-cæcal valve. Under the influence of deep chloroform narcosis, however, this resistance is lessened, and fluids can be thrown into the small intestine.

Insufflation of air per rectum in the treatment of intestinal obstruction has been known since the time of Hippocrates. Gorham was the first to resort to this method of treatment in England.† In comparing the effect of enemata to air insufflation he says: "But the effect is totally different, when air is used, its freedom from all irritating qualities, its elasticity and expansibility give it a decided preference over enemata."

In my paper read at the last meeting of the International Medical Congress‡ I detailed the results of a number of experiments which I made on dogs to determine to my own satisfaction the extent to which the ileo-cæcal valve is permeable to fluids forced from below. In three cases where fluid was forced beyond the ileo-cæcal valve, in two of them the post-mortem revealed multiple lacerations of the peritoneal coat of the large intestines, while the third animal sickened immediately

* Transactions of the Amer. Med. Association. 1878.

† Observations on Intussusception as it occurs in Infants. Guy's Hospital Reports, vol. iii, p. 331.

‡ "An Experimental Contribution to Intestinal Surgery with Special Reference to the Treatment of Intestinal Obstruction."

after the experiment was made, and died, from the effects of the injuries inflicted, eight days later. These experiments combined with clinical experience leave no further doubt that, practically, the ileo-cæcal valve is impermeable to fluids from below, and that for diagnostic and therapeutic purposes it is unsafe and unjustifiable to attempt to force fluids beyond the ileo-cæcal valve. In two cases of ileo-colic invagination, in children less than two years of age, I succeeded in reducing the bowel by steady hydrostatic pressure, while the little patients were under the influence of an anæsthetic and held in the inverted position. In both instances the invagination had existed for two or three days. We should, *a priori*, expect that air and gases on account of their lesser weight and greater elasticity than water, could be forced along the intestinal canal with less force, and for that reason alone, if for no other, should be preferred to water in cases where it appears desirable to distend the intestine below or above the ileo-cæcal valve for diagnostic or therapeutic purposes. I shall therefore call your attention briefly to

3. *Rectal Insufflation of Hydrogen Gas.*

Hydrogen gas is the lightest of all known gases.* I have demonstrated by my experiments that this gas is non-toxic, non-irritant when injected into the connective tissue and into the large serous cavities, and is rapidly removed by absorption. Distension of the entire gastro-intestinal canal with this gas by rectal insufflation, both in man and animals, was never followed by any immediate or remote ill effects. Accurate experiments to determine the force requisite to render the ileo-cæcal valve incompetent by insufflation of air or gas had, previously, not been made, and as it is exceedingly important to obtain accurate information on this subject, I made a number of inflations in animals and man, estimating at the same time the pressure under which it was made, either with a mercury gauge, or a manometer such as is used by gas-fitters and plumbers. The gas was collected in a four-gallon rubber balloon and the inflation made by compressing the balloon. The manometer, or mercury gauge was connected by means of rubber tubing with the rectal tube on one side and the rubber balloon on the other. Numerous experiments showed that when the gas was forced through the opening of a stop-cock, the lumen of which was about the size of a knitting-needle, compression equal to two hundred pounds (90 kilogr.) would never register more than two and

* Rectal Insufflation of Hydrogen Gas an Infallible Test in the Diagnosis of Visceral Injury of the Gastro-Intestinal Canal in Penetrating Wounds of the Abdomen. Jour. Amer. Med. Association, June 23, 30, 1888.

one-half to three pounds of pressure to the square inch. In the living subject the escape of gas from the rectum was prevented by an assistant, pressing the margins or the anus firmly against the rectal tube. A number of experiments made for the special purpose of measuring the resisting capacity of the ileo-cæcal valve to the entrance of gas from the cæcum into the ileum, showed that in a normal condition the valve in a healthy adult person is overcome by rectal inflation under a pressure varying from one and a half to two and one-fourth pounds (0.6 to 1.2 kilo.). This amount of pressure is not sufficient to injure any of the coats of a healthy intestine in any part of its course. As the result of numerous observations on man and animals, I can state that when the inflation is made slowly and continuously there is less danger of inflicting injury than when it is done rapidly or interruptedly. When the patient is placed fully under the influence of an anæsthetic the ileo-cæcal valve yields to a lower pressure than when the abdominal muscles are in a state of rigidity, as this interferes with the requisite degree of distension of the cæcum which is necessary to effect the separation of the margins of the valve. A rubber balloon holding four gallons (twenty litres) is the simplest, safest and most efficient instrument for making rectal insufflation both for diagnostic and curative purposes. Another series of experiments on dogs I made for the purpose of determining the degree of pressure which is required to force hydrogen gas from anus to mouth, the whole length of the gastro-intestinal canal. In all of the experiments the pressure fell rapidly after the ileo-cæcal valve had been opened, but it had again to be increased before the gas reached the stomach and escaped through the stomach tube. It usually required one-half to one pound more pressure to force gas through the entire length of the alimentary canal than when it had to be forced only through the ileo-cæcal valve. Whenever it becomes necessary to conduct the hydrogen gas a considerable distance along the intestines, or through the entire alimentary canal, it is exceedingly important to proceed slowly with the inflation, as under slow gradual distension, half a pound (0.2 kilogr.) of pressure to the square inch of surface will accomplish in time a great deal more without doing harm than four times this amount of pressure if the force is applied quickly and only for a short time. In the dog rectal insufflation of hydrogen gas made under a pressure of one-quarter of a pound, if made very slowly and uninterruptedly, the abdominal walls being completely relaxed by an anæsthetic, will not only overcome the resistance offered by the ileo-cæcal valve, but will prove sufficient to force the gas through the whole length of the alimentary canal.

Experiments made on different portions of the gastro-intestinal canal when in a healthy condition and removed soon after death, proved that laceration did not take place under a pressure of less than eight pounds, and often it had to be increased to twelve pounds. It was found that the resisting power of the intestinal wall is nearly the same throughout the entire length of the canal, and in a normal condition yielded to a diastaltic force of from eight to twelve pounds of pressure. When rupture took place, it either occurred as a longitudinal laceration of the peritoneum on the convex surface of the bowel, or as multiple ruptures from within outwards at the mesenteric attachment. The former result followed rapid, and the latter slow, inflation. The superiority of hydrogen gas inflation over injections of liquids in the mechanical treatment of intestinal obstruction is apparent. Liquid injections cannot safely be forced beyond the ileo-cæcal valve, and even in distending the entire colon by liquids a great deal more force is required than by insufflation with hydrogen gas. Insufflation of hydrogen gas is a valuable means of diagnosis in locating the seat of obstruction before tympanites has set in and therefore best adapted at a time when most needed—during the early stage of intestinal obstruction. If the colon dilates uniformly from the sigmoid flexure to the cæcum the obstruction must be sought for higher up in the intestinal canal. The passage of gas through the ileo-cæcal valve, rendered incompetent by the distension of the cæcum, is always attended by a characteristic gurgling or blowing sound which is always heard most distinctly by applying the ear or stethoscope over the ileo-cæcal region. Not infrequently the sounds are so loud and distinct that they can be heard at a distance of several feet. If the gas passes the ileo-cæcal valve under a pressure not in excess of that required to overcome it in a state of health, and, if after inflation a thorough examination of the ileo-cæcal region by inspection, palpation and percussion reveals nothing abnormal, the search for the obstruction is continued by inflating the small intestines slowly and making frequent examinations of the abdomen to ascertain the height to which inflation has been made and to study the relative position of the different abdominal organs. Inflation is also a useful diagnostic resource in locating the obstruction during laparotomy for intestinal obstruction. The intestine below the seat of obstruction is always empty, collapsed and anæmic as compared with the portion above the obstruction. When the obstruction is located high up in the intestinal canal and the tympanites is extensive the empty portion of the small intestines has by compression become displaced and is often not readily found. In such cases the distension of the bowel from below

will indicate to the surgeon at once the location and length of the intestine below the seat of obstruction and will enable him to search for the obstruction from below upwards. The manipulation of the healthy intact portion of the intestinal canal in the search for the obstruction is by far a less hazardous procedure than the handling of the distended portion above the obstruction rendered paretic, exceedingly vascular, and much softened by the obstruction. In cases where we suspect the presence of a perforation, inflation with hydrogen gas will demonstrate not only its existence, but also its location. Invagination is rare above the ileo-cæcal valve, and its location can be determined by inflation with hydrogen gas, and if resorted to early it may prove the means of effecting reduction. In ileo-cæcal and colonic invagination slow and persistent distension of the colon with hydrogen gas, with the patients completely under the influence of chloroform, is the safest and most efficient means of effecting reduction and should always be resorted to whenever these conditions are recognized or even suspected. Rectal inflation as ordinarily practised by forcing air into the rectum with bellows, or a Davidson's syringe, is not devoid of danger, as the force employed cannot be accurately regulated or estimated.

Bryant* has collected twenty cases of invagination treated by inflation, in three of which it produced rupture of the bowel below the invaginated portion, while in a fourth the child died in collapse shortly after the inflation. He does not look upon inflation as a proper and safe method of treatment in cases of acute invagination, and in the subacute form it should only be resorted to within the first three days, because later on changes in the bowel are almost certain to have taken place, which would render this measure fruitless, and probably dangerous.

Knaggs† reports the particulars of eight cases of invagination where forcible distension of the bowel by air or water was the cause of rupture or other serious injury to the bowel. These cases show that this method of treatment is attended by great risk in children less than one year of age, as six of the eight cases in which harm resulted were children less than eight months old. In Symond's case the abdomen was opened at once after rupture had taken place, and the rupture was sutured. The child, however, was too exhaused to rally from the operation, but at the necropsy the sutured

* Harveian Lectures on the Mode of Death from Acute Intestinal Strangulation and Chronic Intestinal Obstruction. British Medical Journal, 1884, Nov. 22.

† Resection of an Irreducible and Gangrenous Intussusception, etc. The Lancet, 1887, June 4, 11.

bowel was able to resist successfully very considerable distension with water.

Greig* reports five cases of invagination treated by insufflation of air, in four of which it proved successful. In some of the cases the insufflation had to be repeated.

Insufflation of hydrogen gas from a rubber balloon is applicable in all cases of sub-acute and chronic invagination and during the early stage of acute invagination, that is before the passive hyperæmia in the invaginated portion has rendered reduction by this method impossible. Should perforation take place the accident is at once recognized by a uniform distension of the abdomen from the entrance of the hydrogen gas into the peritoneal cavity, as well as by a sudden diminution of pressure readily felt by the person who makes compression of the balloon. The entrance of hydrogen gas into the peritoneal cavity is in itself a harmless occurrence as the gas is non-irritant and perfectly aseptic. In such cases the insufflation must be followed at once by abdominal section and the necessary operative treatment of the invagination.

4. *Tubage of Colon.*

Even a few years ago it was as much a mooted point in reference to how far fluids could be forced beyond the rectum as the permeability of the ileo-cæcal valve is at the present time.

Von Trautvetter† made numerous experiments on the cadaver to determine how far up into the bowel fluids could be injected per rectum. He injected either with an ordinary syringe or through a rectal tube. The fluid used was a solution of ferrocyanide of potassium, and after the injection chloride of iron was applied to different parts of the intestine to test for the presence of the fluid injected. Ordinary injections did not pass beyond the lower portion of the descending colon, while injections made through a long elastic tube reached the cæcum. These experiments are only alluded to as an illustration of the ideas which were entertained in reference to the permeability of the colon to rectal injections at the time O'Bierne first advocated the use of the elastic rectal tube in cases where it was deemed necessary to make high injections. Some authors suggest the introduction of a rectal tube in the treatment of intestinal obstruction as first practised by O'Bierne and claim that with it they have reached the cæcum; but Treves assures us that he has made numerous experi-

* On Insufflation of Air as a Remedy in Intussusception. Edinburgh Med. Journal, October, 1864.

† Wie weit können Fluessigkeiten in den Darmcanal per anum hinauf gespritzt werden? Deutsches Archiv f. klinische Medicin, B. IV, p. 476.

ments on the cadaver and has never succeeded in passing it farther than the sigmoid flexure.

Cadge* states that even O'Bierne never claimed that the elastic rectal tube could be inserted farther than the sigmoid flexure. Cadge made numerous attempts on the cadaver and was never able to reach the descending colon. In cases where the tube was introduced to a depth of twenty to thirty inches he found that the tip of the instrument remained in contact with the intestinal wall, and that this portion of the bowel is pushed forward when the end of the instrument can be felt through the abdominal wall at a higher point. In the administration of ordinary injections the introduction of a rectal tube is superfluous, as in Hegar's knee-chest position the fluid from an ordinary fountain syringe will follow the course of the colon and advance as far as the cæcum.

Hegar† seldom found it necessary to elevate the funnel more than one foot, a column of water corresponding to this elevation being found sufficient to force the fluid as far as the cæcum and as he believes sometimes beyond the ileo-cæcal valve. The legitimate indications for tubage of the colon are the following:

1. Detection and location of obstruction below the sigmoid flexure.
2. To relieve gaseous distension of the colon.
3. To administer high nutrient enemata in cases where it becomes necessary to maintain the strength of the patient by this method of alimentation.

5. *Manual Exploration by the Rectum.*

The introduction of the whole hand into the rectum as a means of diagnosis was devised and first practised by Simon. This method of exploration is only applicable in the adult. Simon and his numerous followers claim that the hand can be introduced sufficiently far to enable the surgeon to palpate most of the abdominal organs. Nussbaum assures us that he has felt more than once the tip of the sternum with the hand employed in the manual exploration by the rectum.

Wagstaff‡ places great stress on the importance of manual exploration by the rectum as a diagnostic measure, as appears from one of his conclusions: "That the causes of obstruction can generally be determined by the history of present and past illnesses and by thorough external examination, and that manual exploration by the rec-

* Case of Intestinal Obstruction with Remarks. British Medical Journal, 1888.

† Ueber Einführung von Flüssigkeiten in Harnblase und Darm. Deutsche Klinik, 1873, No. 8.

‡ On Intestinal Obstruction. St. Thomas' Hospital Reports, New Series, vol. iv, 1873.

tum is certainly the greatest advance in our means of diagnosis." The glowing accounts of the value of this method of exploration were soon followed by the report of disastrous consequences such as rupture of the gut and permanent loss of function of the sphincter muscles. Manual exploration by the rectum should only be undertaken by surgeons with small slender hands, and the examination should be made with the patient fully under the influence of an anæsthetic and always with the utmost care and gentleness. This method of examination will enable the surgeon to ascertain the location and nature of obstructions below the sigmoid flexure, the existence of volvulus at the sigmoid flexure, and to determine the presence of pathological conditions in the pelvis which might have caused the obstruction. As a therapeutic measure this procedure can be employed in the removal of foreign bodies or an enterolith within reach of the hand, and in the reduction of some cases of intussusception where the invaginated portion of the bowel has passed beyond the sigmoid flexure.

6. *Taxis and Massage.*

Hutchinson decidedly opposes early operative interference in cases of intestinal obstruction, and expects little from it in those which have been some time in existence. He advocates what he terms *abdominal taxis*, under an anæsthetic. By abdominal taxis he means a thorough kneading of the abdomen, with inversion of the patient, shaking him, tossing him in a blanket, and a variety of rough performances, the object being to dislodge the bowel, or untwist the volvulus. At the same time he advises large enemata and cathartics. If these means do not lead to the desired result he waits and keeps the patient on a low diet, and administers opium or belladonna internally, and subsequently repeats the abdominal taxis. He reports a number of cases successfully treated by this method. It is doubtful if any surgeon at the present time could be found who would be willing to subject his patients to such a primitive treatment as advised by Hutchinson. In most forms of intestinal obstruction such treatment is not only unscientific and useless, but attended by great risk to life, as the violent movements would not only aggravate the mechanical difficulties which have caused the obstruction, but might produce rupture of the distended intestine, and could not fail in causing exacerbation of the vascular disturbances. Taxis and massage scientifically practised have a limited range of application in the treatment of intestinal obstruction when it is due to the presence of a foreign body, a fæcal accumulation or an enterolith, and should only be resorted to before these causes have

developed inflammatory changes at the seat of impaction. A number of such cases are on record where this treatment proved successful.

Streubel* succeeded in a boy eleven years of age suffering from intestinal obstruction due to the impaction of a mass of cherry stones above the ileo-cæcal valve in removing the cause of obstruction by submitting the swelling to gentle massage frequently repeated.

Marotte† gives an account of a case of acute intestinal obstruction which had lasted for some days when fæcal vomiting set in, and in which the usual internal treatment with opiates and chloroform afforded no relief, which was promptly cured by palpation of the abdomen made for the purpose of locating the seat of obstruction. The patient experienced a sensation at the time as though the obstruction had given way and soon afterwards had a number of evacuations in which a gall-stone the size of a walnut was found. The author refers to five cases of intestinal obstruction caused by the presence of gall-stones, collected by Fauconneau-Dufresne. One of these cases came under the observation of Mayo. In this case the gall-stone was also dislodged by palpation, followed by cessation of the symptoms of obstruction and recovery of the patient. The remaining four patients died. In cases of fæcal accumulation in any portion of the large intestine from the cæcum to the sigmoid flexure unattended by inflammation and giving rise to symptoms of obstruction, and not amenable to irrigation of the colon, massage and taxis should be made while the patient is under the influence of an anæsthetic so as to enable the operator to break up the mass and to force it onwards in the interior of the bowel to a point where peristaltic action is more active.

7. *Puncture of Intestine.*

Advanced cases of intestinal obstruction are always attended by great distension of the bowel on the proximal side of the obstruction, a condition which causes increased intra-abdominal pressure. The tympanitic distension of the abdomen may be so great as to destroy life by the suspension of important functions from mechanical pressure. The diaphragm is pushed upwards so far that death may ensue from asphyxia, or the circulation is so far impeded by compression of the heart as to cause death from syncope. Great distension of the intestines on the proximal side of the obstruction also aggravates the mechanical difficulties which have caused the obstruction, as the dis-

* Ueber Erkennung und Behandlung der inneren Darmeinklemmung. Prager vierteljahrsschrift, B. XV, 1858.

† Einklemmung eines Gallen-steines im Darme. Heilung durch Palpation des Bauches. Schmidt's Jahrbücher, B. 93, p. 189.

tended bowel under such circumstances forms numerous flexions which interfere with the free passage of its contents as far as the obstruction, at the same time the distended coils may render the bowel less permeable at the seat of obstruction by compression. The anxiety with which surgeons look upon extensive tympanites following the course of intestinal obstruction is universal, hence it is only natural that for a long time it has been customary to make attempts in affording relief by puncturing the distended bowel through the abdominal wall. A small trocar was usually employed for this purpose and since the introduction of the hypodermic needle and the aspirator a hollow needle of one of these instruments has been used. Cases have been reported where repeated punctures not only afforded relief, but finally led to a permanent cure. In some instances the cannula of a trocar after puncture was allowed to remain until a fæcal fistula had been established. An intestine distended to the extent of giving rise to distressing and dangerous intra-abdominal pressure is always in a paretic condition, unable to expel its contents and whatever escapes through a needle or the cannula of a trocar is expelled by the contraction of the abdominal wall. This applies not only to the liquid, but also to the gaseous contents. I have repeatedly satisfied myself during operations on the living subject, and in animals where the obstruction was caused artificially that mere puncture empties only a limited space not more than six to eight inches on each side of the puncture. If aspiration is practiced at the same time the effect is doubled; further evacuation is arrested by flexions among the distended coils and valvular closure of the collapsed segment of the intestine at the terminus of the evacuated area. The recorded results of puncture of the intestine represent largely only the successful cases, while the numerous failures seldom find their way into literature. Puncture of a healthy intestine with a needle of moderate size is never followed by extravasation, as the irritation incident to the puncture always produces muscular contractions which start from the point of puncture and at once obliterate the canal made by the needle. Puncture of a paretic intestine is always attended by great risk of extravasation, as the muscular coat has lost its tonicity and the track of the needle or trocar is slower in closing, or remains permanently patent. Numerous cases have been reported where a mere needle puncture gave rise to escape of fæcal contents into the peritoneal cavity. As the removal of the tympanites is the means only in exceptional cases of removing the cause of obstruction, and as the puncture of a distended paretic intestine is never devoid of risk of causing fæcal extravasation the legitimate indications for puncture of the intestine are extremely lim-

ited. If employed at all puncture is only applicable to cases where no mechanical obstruction is present, and where the rapid distension of the abdomen, in itself, constitutes an imminent source of danger. Puncture should never be resorted to with a view of removing liquid contents; its use should be limited to the evacuation of gases. For this purpose one of the smaller needles of an aspirator should be used. The point of the needle should be sharp so that it can be readily passed through the intestinal wall. The needle should always be thoroughly disinfected by heating it in the flame of an alcohol lamp. The point of puncture should be made at the most prominent point and the instrument pushed boldly forwards until all resistance is overcome. As soon as gas escapes the intra-abdominal pressure should be increased by gentle and uniform compression of the abdominal walls. As soon as gas ceases to escape aspiration should be made and continued as long as anything can be evacuated, and until the needle is withdrawn but not at the time it is withdrawn. Should it be possible to ascertain the location and direction of the part of the intestine to be punctured, it is advisable to make the puncture obliquely in the long axis of the bowel so as to guard more effectually against extravasation.

8. *Uniform and Uninterrupted Compression of the Abdomen.*

In all cases of intestinal obstruction, but more particularly in the chronic form, uniform firm support of the abdomen affords relief to the patient and is one of the best means of preventing rapid distension of the intestine above the seat of obstruction. Fixation and equable compression are resorted to in other parts of the body as the best known means in controlling muscular spasm. It is only reasonable to expect that the same measures should prove useful in retarding, if not preventing, the violent peristalsis in cases of intestinal obstruction, and especially in preventing over-distension of the intestine. Equable compression of the abdomen should be made before great distension has occurred. Uniform compression of the abdomen is best secured by padding the iliac regions with absorbent cotton and then enveloping the body from the pubes to the tip of the sternum with broad strips of adhesive plaster which should be made to overlap each other.

9. *Enterotomy.*

In 1840 Nélaton made the first enterotomy for intestinal obstruction. He conceived the propriety of such an operation from Mannoury, who in his thesis in 1819, first called attention to the formation

of a preternatural anus in cases of intestinal obstruction. Nélaton taught that by opening the abdomen in the right inguinal region and seizing the first distended coil that might present the surgeon almost without exception would establish the artificial opening in the bowel near the ileo-cæcal region. The mortality of enterotomy has been nearly as great as that of laparotomy with removal of the cause of obstruction and on this score alone its further application should be limited to exceptional cases, cases where a radical operation is inadmissible on account of the nature of the obstruction or the enfeebled condition of the patient. No one who under the pressure of circumstances has been forced to establish a preternatural anus has left his patient with a feeling of satisfaction, as he must have been sadly impressed with the fact, that, at best, he has only succeeded in relieving the urgent symptoms of the obstruction, while he has failed in removing the cause, and consequently also in restoring the continuity of the intestinal canal. A patient with an artificial anus is indeed an object of pity, as experience has sufficiently demonstrated how difficult it is in many instances to close the abdominal opening, even after the cause of obstruction is subsequently removed or corrected spontaneously, without exposing him a second time to the risks of life incident to another abdominal section. If the causes which have led to the obstruction are of a permanent character, all attempts at closing the fistulous opening will, of course, prove worse than useless, and the patient is condemned to suffer from this loathsome condition for the balance of his life-time without a hope of ultimate relief. I believe I can safely make the statement without fear of contradiction that most of these unfortunate patients would prefer death itself to such a life of misery.

In performing enterotomy the surgeon has no means of selecting the most desirable place in the intestine for making the opening. The only rule laid down by the text-books, and the only one applicable in such a case, is to secure in the wound and open the first distended loop which presents itself. It not infrequently happens that the opening is made far above the seat of the obstruction, an occurrence which is attended by two immediate sources of danger: 1. Physiological exclusion of a large portion of the intestinal canal, which in the event the patient recovers from the operation and the cause of obstruction remains permanent is followed by marasmus which in itself may prove the cause of a subsequent fatal issue. 2. The portion of intestine between the artificial opening and the seat of the obstruction being the part which has suffered the most from the effects of the obstruction remains distended and continues to exert the same deleterious effect as before the operation. Many able surgeons, even at the present

time, prefer enterotomy to laparotomy and mention as principal arguments in its favor that it requires less time in its execution and can therefore be resorted to in patients where a radical operation for this reason alone would be inadmissible ; again, it is claimed that the intestine above the seat of obstruction is not in a condition for direct operative measures which have in view the restoration of the continuity of the intestinal canal. It must, however, not be forgotten that in quite a number of cases the second objection to a radical operation does not apply, as the removal of the cause of obstruction is accomplished without interrupting the continuity of the intestinal canal, and as I shall show further on, in the remaining cases, where the cause of obstruction cannot be removed the continuity of the intestinal canal can be restored by making an intestinal anastomosis which can be done without greater immediate or remote risk of life than attends enterotomy. As the technique of radical operations for intestinal obstruction will be improved, the indications for enterotomy will diminish. As long as the patient's strength warrants a radical operation enterotomy should never be performed. In patients so enfeebled that the administration of an anæsthetic would be attended by imminent danger to life an enterotomy can be made without anæsthesia and under such circumstances will be the means of occasionally saving a life which otherwise would be lost. The operation is performed by making an incision not more than two and a half inches in length in the right iliac region, above and parallel to the outer half of Poupart's ligament. The tissues should be recognized as they are divided, without, however, using a director until the subperitoneal fat is reached. This layer is divided bluntly and pushed aside when the peritoneum comes into view. This membrane is seized with a toothed forceps or lifted up with a sharp hook and carefully incised and divided upon a grooved director. The peritoneum is united all around with the skin by a continued suture. Almost without exception, a distended knuckle of intestine, readily recognized by its size and color, presents itself in the wound, and is united with the external wound ; and after it is securely fastened, an incision large enough to admit the tip of the index finger is made in the bowel and the margins of the visceral wound sutured separately to the external wound by a single suture on each side, so as to secure patency of the opening. On incising the bowel the surgeon is often disappointed at the small amount of gas and fluid which escape, and it is frequently several hours before a free escape takes place and the abdominal distension begins to diminish. The escape of intestinal contents is expedited by the introduction of a large sized Nélaton's catheter.

10. *Colotomy.*

Colotomy will always retain a place in operative surgery as a palliative and life-prolonging procedure in the treatment of carcinomatous stenosis of the lower portion of the colon, and in cases of inoperable carcinoma of the rectum. The recent advances in abdominal surgery have rendered the old-fashioned lumbar or extra-peritoneal operation obsolete. The modern operation is made by opening the peritoneal cavity in the right or left groin according to the indications which are to be fulfilled, and one of its principal objects is to terminate the intestinal canal at the artificial anus so as to provide absolute physiological rest for the portion of the bowel below it. The obvious disadvantages of colotomy, as usually performed, are cited by Maydl* as the reasons which induced him to devise the operation which he has described. He opens the peritoneal cavity by Littre's incision, and draws a loop of intestine forward till its mesenteric attachment is on a level with the external incision. Through a slit in the mesentery close to the gut is inserted a hard rubber cylinder wrapped in iodoform gauze; a goose-quill will answer the same purpose. This device holds the intestine in the wound and prevents its return into the abdominal cavity. By means of a row of sutures placed on each side of the prolapsed gut, including the serous and muscular coats, the two limbs of the flexure, in so far as they lie in the abdominal wound, are stitched together beneath the rubber support. If the intestine is to be opened immediately, it is stitched to the parietal peritoneum of the abdominal incision and the latter protected by iodoform collodium. If the bowel is to be incised later, the latter is not stitched to the peritoneum, but surrounded by iodoform gauze packed in beneath the rubber support, the incision of the bowel being made four or six days later after the peritoneal cavity has been excluded by firm adhesions. If the artificial anus is made for lesions incapable of subsequent removal, a transverse opening including one-third of the periphery of the bowel, is made by the thermo-cautery, drainage tubes are inserted into the two lumina, and the intestine is carefully washed out. If the progress of the case is satisfactory the bowel is cut through completely in two or three weeks, the rubber support serving a useful purpose as a guide in making this incision, a few sutures will serve to secure the cut end to the skin. If the direction of the muscular fibres has been respected in making the abdominal incision, the patient is provided with such an efficient sphincter that a large drainage tube is required to keep the opening patulous.

* Centralblatt f. Chirurgie, 1888, No. 24.

Should the artificial anus only be a temporary one the incision in the intestine is made in a longitudinal direction. When it has become desirable to close the artificial opening, the rubber support is removed, after which the bowel retracts and the opening often closes without any further treatment. If the adhesions are too firm for this they are removed and the bowel is sutured and returned into the peritoneal cavity. Lauenstein accomplishes the same object by suturing first the peritoneum to the skin, thus lining the external incision by peritoneum, then drawing out a loop of intestine and closing the parietal wound by sutures passing through the meso-colon of the prolapsed portion of intestine which is thus fastened in the abdominal incision; next the serosa of each limb of the prolapsed loop is stitched through its entire circumference to the parietal peritoneum.

An interesting discussion has arisen lately in Germany in regard to a step in the operation of colotomy which was described by Knie.* So far the operation has been only done on dogs. It consists in opening the abdomen transversely in the region of the transverse colon, stitching the peritoneum to the edges of the wound, drawing out the colon, making a slit in the meso-colon near the gut with a blunt instrument and closing the abdominal wound with two or three sutures, which are passed through the slit in the meso-colon. The object of this is to secure a loop of the colon outside of the abdominal cavity. This loop is to be carefully stitched at each side to the edge of the (now) two abdominal openings, after which it is to be opened by an incision, or if the symptoms are not urgent the incision is postponed for a few days until the peritoneal cavity has been shut off by adhesions. As a general thing Lauenstein's operation will be found simplest and should receive the preference in ordinary cases. The modern operation of colotomy is indicated in cases of congenital atresia of the rectum when the bowel cannot be readily reached from below; also in cases of carcinoma of the sigmoid flexure and the rectum not amenable to a radical operation. Finally the operation might become necessary in irreducible colic invagination in which for anatomical reasons resection or anastomosis cannot be done.

11. *Abdominal Section.*

A radical operation in the treatment of intestinal obstruction embraces the fulfillment of two principal indications: 1. The removal or rendering harmless of the cause of obstruction. 2. The immediate restoration of the continuity of the intestinal canal. To meet the first indication the cause of the obstruction must be found, its nature de-

* Centralblatt f. Chirurgie, May 5, 1888.

termined, and whenever advisable or practicable, it is removed, a step in the operation which may be very easy, or may demand a most formidable and serious undertaking, more especially in cases where the pathological conditions which have given rise to the obstruction are of such a nature as to constitute in themselves an imminent or remote source of danger, as, for instance, malignant disease or gangrene of the bowel from constriction. Abdominal section in the treatment of intestinal obstruction has so far been attended by a fearful mortality. Owing to the fact that most operations were performed when the patients were in collapse, or when the parts involved in the obstruction had undergone advanced and often irreparable pathological conditions.

Ashhurst* tabulated fifty-seven cases of laparotomy for acute intestinal obstruction from other causes than from intussusception, from which it will be seen that only eighteen terminated favorably, so that at that time the mortality of laparotomy in cases of intestinal obstruction other than intussusception, was over 68 per cent. Most of these operations were performed without antiseptic precautions.

Schramm has collected one hundred and ninety cases of intestinal strangulation treated by laparotomy, including three cases observed by himself in the practice of Mikulicz. He alludes to the difficulties encountered in the diagnosis of these cases and pleads in favor of early operative interference. Of this number 64.2 per cent. died, the mortality before the antiseptic treatment of wounds being 73 per cent., and since that time 58 per cent. The cause of strangulation and mortality attending each kind may be gleaned from the following table :

27	times,	Invagination,	8	cured,	19 died.
49	"	Bands, or intestinal diverticula	13	"	36 "
16	"	Adhesions,	7	"	9 "
11	"	Reduction *en masse*,	6	"	5 "
10	"	Torsions,	1	"	9 "
12	"	Knotting of bowel,	4	"	8 "
12	"	Internal strangulation,	4	"	8 "
7	"	Foreign bodies,	4	"	3 "
38	"	Neoplasms,	16	"	22 "
8	"	Unknown causes,	4	"	3 "

Curtis† has collected the cases of intestinal obstruction treated by abdominal section since the year 1873, consequently since the antiseptic treatment of wounds was introduced. Table I. shows a total

* Amer. Jour. Med. Sciences, July, 1874.

† The Results of Laparotomy for Acute Intestinal Obstruction. Annals of Surgery, May, 1888.

of three hundred and twenty-eight cases with one hundred and two recoveries and two hundred and twenty-six deaths, the percentage of mortality being 68.9—a higher percentage than that of Schramm's collection. Table III. shows that in one hundred and one cases, the failure of the operation was due directly to the unfavorable condition of the patient, who was in a dying condition in eight cases. In the majority of the cases with complications, forty-one in all, the fatal result was also really due to the condition of the patient, for the existence of peritonitis or gangrene of the bowel at the time of operation shows that there had been too much delay in resorting to operative measures and most of these cases died a few hours ofter operation. In twenty-eight cases the cause of obstruction was not found, or could not be removed, and in eleven the reports are so defective that the cause of death cannot be ascertained from them. Of the remaining forty-five fatal cases, thirteen died of shock, in three cases the unusual length of the operation was probably the direct cause of death, and in seventeen cases, sepsis, probably due to the operation was the cause of death. In twelve cases the cause could not be definitely learned, but as death was followed in most of them within twenty-four hours after the operation, it was probably shock and exhaustion. In two hundred and forty-seven cases where the cause of obstruction was removed, the mortality was only 62.7 per cent.; while in forty-seven in which it was not done, the mortality was 86.4 per cent. In forty-one cases where the obstruction consisted of invagination, volvulus, adhesions, bands and internal incarceration, in which the obstruction was not removed, not a single one recovered, although in sixteen an artificial anus was made.

The greatest mortality attended cases where from any cause suturing of the bowel was made, attaining the extreme point of 86.6 per cent. in forty-five cases. The necessity for a short operation is well shown by the cases collected by Curtis, which give a mortality of 57 per cent. in one hundred and ninety cases in which the operative interference was limited to relieving the obstruction, without wounding the bowel, while it rose to 73 per cent. in fifteen cases in which it became necessary to establish an artificial anus after the obstruction had been removed, and to 83 per cent. in forty-eight cases in which the gut had to be sutured. In all these cases the true danger lay in the length of the operation, for death resulted from the immediate effects of the operation in most of the cases. These statistics show the value and importance of an early operation, as sometimes delay of only a few hours will bring complications which not only necessitate more time in their removal, but will at the same time necessitate a resection or an anastomosis, which, had the operation been done at

an earlier date, might have been obviated. The older text-books on surgery always cautioned the practitioner to postpone the operative treatment of a strangulated hernia for a certain length of time which was often consumed in vain attempts at reduction, consequently the old statistics of herniotomy present a high mortality when contrasted with recent operations. This striking contrast was brought about not solely by an improved technique, or by the introduction of antiseptic surgery, but it is largely owing to the modern teaching that it is dangerous to delay an operation, if the strangulation is not relieved by gentle taxis persisted in not for hours and days, but only for fifteen minutes, and at the utmost for half an hour. Modern surgery recognizes the safety of an early operation for strangulated hernia, and the results which have been obtained have demonstrated the wisdom of the change in practice. Vain and prolonged attempts at reduction of a strangulated hernia aggravate the causes which have produced the strangulation and hasten the pathological changes in the strangulated intestinal loop which arise from the strangulation. If delay is dangerous in a case of strangulated hernia, what can we expect of a laparotomy for intestinal obstruction when postponed until the patient has been exhausted or the local conditions necessitate complicated operative measures? In strangulated hernia the destructive changes in the constricted intestinal loop affect by continuity and contiguity primarily only a limited peritoneal surface, while in intestinal obstruction the seat of obstruction is in direct communication with the entire peritoneal cavity which becomes the seat of a rapidly fatal septic inflammation if gangrene or perforation have caused the inflammation. A recent intestinal obstruction due to a change of visceral relations such as flexion, volvulus, and invagination if subjected to operative treatment before consecutive pathological changes have occurred would offer but little difficulty to mechanical correction of the displacement, and as in such cases the intestinal tube would be in a healthy intact condition the danger of the operation would not be greater than that of an ordinary ovariotomy. I think enough has been said in favor of an early operation in all cases where the signs and symptoms indicate the existence of an obstruction which does not yield to milder measures. Intestinal obstruction is a surgical lesion in every sense of the word, and should be treated from the very beginning upon common sense surgical principles. To temporize with such cases by the administration of uncertain drugs must be looked upon as evidence of ignorance or a relic of barbarism. The treatment of a case of intestinal obstruction upon the expectant plan until gangrene or perforation has taken place, which, if submitted in

time to proper surgical treatment, might have been cured by one stroke of the scissors should be considered as gross negligence for which the modern aggressive physician and surgeon can offer no justification or apology. The future progress of abdominal surgery will conquer the difficulties which now surround the diagnosis and treatment of intestinal obstruction. Experimental research and more careful and accurate clinical observation will solve the difficult problems which now surround us in this as yet unexplored field of surgical labor. Laparotomy for intestinal obstruction should not be undertaken by every tyro in surgery. The one who undertakes it should be master of the situation, familiar with every detail of the technique of different operative procedures and fully conversant with the manifold complications with which he may be confronted. Every possible contingency must be fully considered before the abdomen is opened, as this is an operation where unnecessary hesitation and loss of time weigh heavily in the balance on the side of failure. Like other abdominal operations laparotomy cannot be mastered in the lecture room or even under the tuition of experienced surgeons. Those who expect to perform this operation must, in the first place, have a perfect knowledge of the structure and relations of all the abdominal organs in conditions of health and disease and must acquire the necessary operative skill on the cadaver, and then what is still more important, should make the more important operations on the living animal. It is not necessary or even desirable that every physician should become a laparotomist, but in every section of the country, distant from the medical centres, some one should interest himself in this branch of surgery and prepare himself to meet such emergencies. Unlike a patient suffering from an ovarian tumor, patients affected with acute intestinal obstruction cannot be transported great distances, and as loss of time leads to disastrous consequences it is not always possible to secure the services of a surgeon versed in abdominal surgery from a distance, and for such contingencies I should recommend that at least one member of every county or district medical society should familiarize himself sufficiently with the details of intestinal surgery, so that patients in his neighborhood may reap the advantages of modern aggressive surgery at the proper time and at their own homes.

a. Preparations for the Operation.—The most careful and perfect preparations should be made for the operation. The presence of at least three reliable and intelligent assistants is an absolute necessity. As an exventration may become necessary and exposure of the intestines to a cool atmosphere is productive of shock an equable temperature of from 80° to 85° F. should be maintained in the operating room

from the beginning to the end of the operation. Opinions among operators may still differ as to the wisdom or even propriety of using antiseptics in a healthy peritoneal cavity, but no one at the present day would have the courage to oppose the use of *strictest antiseptic precautions in securing an aseptic condition for everything that will come in contact with the wound or the peritoneal surfaces.* The operating room must be cleared of everything, except the bare walls and windows, and the whole of its interior surface washed with a strong solution of sublimate or carbolic acid. The table and stands are disinfected in a similar manner. The blankets if not perfectly aseptic can be covered with linen sheets. Heat is the most reliable, safest and cheapest sterilizer, and can be used for the disinfection of towels, napkins, instruments and wash-basins. *The operator must satisfy himself of the aseptic nature of everything which is used inside of the peritoneal cavity.* The abdomen of the patient and the operator's and assistants' hands are rendered aseptic by washing with potash soap and warm water, and afterwards with a 1-1000 solution of sublimate. The water used for solutions and sponges is sterilized by boiling. For the protection of prolapsed intestine, compresses of aseptic gauze or napkins are better than sponges, and the temperature of the parts is maintained, not by pouring warm water on the compresses, but by removing them and applying new ones wrung out of warm water. The danger of using corrosive sublimate solution within the peritoneal cavity is well shown by Kümmell's experience.* He made nine laparotomies, using for the sponges a 1-5000 solution of sublimate and all of the patients recovered without an unpleasant symptom. Then he met with two cases of sublimate intoxication in succession, having used the same strength of the solution. One of the patients died on the fourth day and the post-mortem revealed intestinal lesions characteristic of acute mercurial poisoning. The other patient recovered after a lingering illness, during which the symptoms of mercurial intoxication were well marked. He cautions against the use of sublimate in debilitated, anæmic individuals, or in patients suffering from renal disease. In cases where the peritoneal cavity is in a healthy aseptic condition the use of any of the stronger antiseptics is contra-indicated. For the cases where septic peritonitis, suppuration, gangrene or perforation exists, a two per cent. solution of boracic acid, or a saturated solution of salicylic acid (0.3 per cent.) should be kept in readiness for flushing the abdominal cavity. Bands of rubber or

* Ueber Sublimat-intoxication bei Laparotomien. Centralblatt f. Chirurgie, 1886, No. 22.

fine rubber tubing should always be on hand as well as a good assortment of aseptic silk, well prepared catgut, glass drains, decalcified perforated bone plates, and a good assortment of needles and forceps. Stimulants and means to make auto-transfusion must never be absent, as prompt interference when symptoms of shock make their appearance may prove the means to restore the force of the circulation until reaction can be established by other measures.

Weir* suggests the administration of a hypodermatic injection of 1-100 to 1-80 of a grain of atropia and a large rectal enema of brandy before the anæsthesia for the purpose of increasing the force of the heart's action. During the operation the peripheral circulation is best kept up by placing the patient on a rubber bed, filled with hot water, and in the absence of such a contrivance by applying to the extremities rubber bags or bottles filled with hot water.

b. Anæsthesia.—A number of American surgeons have recently expressed a preference for chloroform to ether as an anæsthetic in abdominal operations, as it is less likely to produce vomiting before, during and after the operation. Another serious objection to the use of ether, especially in persons advanced in years, is the frequency with which bronchitis is produced when this anæsthetic is exclusively used. The use of chloroform, however, is also not free from objection. The depressing effect of this anæsthetic on the action of the heart is well known, and as the force of the circulation is almost without exception seriously impaired in these cases, its prolonged use might result in dangerous consequences. The best course to pursue is to follow the use of chloroform by ether. The retching and bronchorrhœa are prevented by placing the patient first under the influence of chloroform and the deleterious effects of the prolonged use of this agent are avoided by keeping up the narcosis during the operation with ether. From the time the first incision is made until the abdominal wound is closed the patient must be kept profoundly under the influence of the anæsthetic, inasmuch as any interruption will cause an unnecessary delay in the operation and may result in complications which are not easily remedied. Irrigation of the stomach should always precede the administration of the anæsthetic, as evacuation of the stomach by preventing vomiting will guard against the entrance of foreign material into the larynx and trachea, which might produce asphyxia during the narcosis or pneumonia later.

c. Incision.—Differences of opinion still exist among surgeons as to the size and location of the abdominal incision. The advocates of

* On the Technique of the Operations for the Relief of Intestinal Obstruction. The Medical Record, Feb. 2, 1888.

exventration argue in favor of a long incision through the median line. Kümmell advises that it should be carried from the ensiform cartilage to the pubes for the purpose of affording free access to every part of the abdominal cavity. While, on the other hand, a number of distinguished surgeons, among them Madelung, Czerny and Obalinski are in favor of a small incision. Polaillon* is strongly in favor of a lateral incision in opening the abdomen for the relief of intestinal obstruction in all cases where the seat of obstruction can be reached more directly by such incision. He also claims that in cases where extensive meteorismus is present the distended intestines are more prone to prolapse and are more difficult to return through a median than a lateral incision. He thinks that this is due to a lesser degree of intra-abdominal pressure in the iliac than the middle abdominal region, and that in the former the muscular fibres keep the margins of the wound in contact. He opens the abdomen in the ilio-inguinal region by an incision parallel with the fibres of the external oblique muscle, and if occasion requires, it can be made sufficiently large to permit exploration of the abdomen by the introduction of the whole hand. In lateral laparotomy exploration is less easy, but this operation is indicated in all cases of localized obstruction, circumscribed adhesion, or when any symptoms render it probable that the obstruction exists in one or the other side of the abdominal cavity. In case a distinct swelling, the probable cause of the obstruction can be detected in the ileo-cæcal region, the ascending or descending colon, as will probably be the case in ileo-cæcal and colic invagination, volvulus of the sigmoid flexure, tumors of the cæcum and colon, the incision should be made over the most prominent part of the swelling, as such a course affords the most ready access to the seat of obstruction and greatly facilitates the operative procedures which may become necessary. In reference to these points J. Greig Smith regards it as only less than a surgical calamity to perform median laparotomy for obstruction in the colon, since in the majority of cases it must, he says, be supplemented by a transverse or lumbar incision.

In all other forms of intestinal obstruction and in all cases where it is found impossible to ascertain the nature and location of the obstruction the incision should be made through the median line. Not much time should be consumed in making the external incision. With successive strokes of a sharp scalpel the tissues are rapidly divided until the subperitoneal layer of fat is reached. This is picked up and nipped between two toothed forceps ; when the peritoneum comes into view it is seized and divided in a similar manner. The incision is then

* Gazette Médicale de Paris, April 25, 1885.

enlarged as circumstances may require by introducing the left index and middle finger into the peritoneal cavity and dividing the tissues with a blunt-pointed bistoury or scalpel between them. Hæmorrhage is arrested as it occurs by applying hæmostatic forceps to the bleeding points which in most instances obviates the application of ligatures. In reference to the size of the incision this will vary in accordance with the difficulties which are encountered in locating the seat of obstruction and in removing the cause, or causes, which have produced the occlusion. With few, if any exceptions, it must be large enough to admit the introduction of the whole hand. As a rule it may be stated that the ease in diagnosis increases with the size of the incision, and the danger which attends searching in the dark for the seat of obstruction more than overbalances the slight increase of risk incident to a large incision. Intra-abdominal manual exploration through a small incision is, in most instances, an unreliable diagnostic measure, as the cause of obstruction may be of such a character as entirely to elude such method of examination. It is a well known fact that the location of the seat of obstruction even in the post-mortem room after a full abdominal section has sometimes been found a difficult task. A large incision shortens the operation by facilitating the intra-abdominal examination and the operative treatment of the obstruction and the immediate risks of the operation are diminished in proportion to the shortening of the time required in its performance.

d. Intra-abdominal Examination.—The first and most important object of the external incision is to enable the surgeon to make a satisfactory intra-abdominal examination. Unless a positive diagnosis has been made beforehand the first incision is an exploratory one. Exploration of the abdomen for the purpose of locating the obstruction and ascertaining its nature is a more difficult procedure than in cases of abdominal tumors, and on this account the first or exploratory incision must be made at least large enough to enable the surgeon to combine ocular inspection with manual exploration.

Smith says:* "The best guide to the seat of operation is not manual exploration, but visual examination, assisted, if necessary, by extrusion of bowel."

The surgeon must bear in mind that in nine out of ten cases of intestinal obstruction the cause is located in the lower portion of the abdominal cavity, below the umbilicus, and that in the great majority of these cases it will be found either in the right or left inguinal region.

Bryant lays down the rule that in all abdominal operations for intes-

* The British Medical Journal, August 29, 1885.

tinal obstruction, when the seat of obstruction cannot be readily found, the surgeon should find the cæcum, since it is from it that he will obtain his best guide. If this be distended, he will at once know that the cause of obstruction is below, if it be found collapsed, or not tense, the obstruction must be higher up. The naked eye appearances of the intestine that presents itself in the incision will serve a useful purpose in deciding whether it belongs to the part of intestine above or below the seat of obstruction. In all cases of intestinal obstruction the bowel above the seat of obstruction is dilated and congested, while below the obstruction it is empty, pale and contracted. The contents of the presenting loop, if distended, will also indicate whether it is near or distant from the obstruction ; if near, it will probably contain fluid fæces and gas, if distant only gas. If the obstruction is located in the lower portion of the small intestine, or in any portion of the colon, without exception, a distended loop above the obstruction presents itself in the wound.

Fowler* has called attention to the fact that in all forms of intestinal obstruction the empty contracted portion of the intestine corresponding to the part below the obstruction is always found in the pelvis, and that it may be most easily reached towards the right side. He explains this on the supposition that during the violent and continued peristalsis and gradual distension of the bowel above the obstruction, the smaller and less active portion of bowel below, after expelling its contents, is forced downwards into the pelvis, whilst the distended, and therefore specifically lighter, portions rise to the surface. The pelvis also is too small to hold a distended loop. If the seat of obstruction cannot be readily found by manual exploration of the regions where it occurs most frequently two methods of further examination present themselves. The presenting bowel is drawn forward into the wound and systematically examined step by step as it glides through the fingers of the surgeon who replaces the loops as they are examined. This method of examination is only safe and practicable where the distension of the intestines is moderate, and the intra-abdominal pressure not extensive, so that loop after loop can be drawn forward, examined and returned without injury to the intestine. If this method of examination is selected it would be advisable to secure the portion of intestine first examined near the wound by passing a strip of gauze through its mesentery, so that in case the obstruction is not found in one direction the examination in the opposite direction can be made without passing the portion already examined again through the operator's hands. Mikulicz attains the same object by an assistant holding the first

* The Lancet, June 30, 1883.

knuckle that appears against one of the angles of the wound while the operator examines and returns immediatcly coil after coil until the obstruction is found. During the examination prolapse of the intestines is prevented by an assistant who guards the opening with an antiseptic compress, and thus as inspection is progressing, unnecessary exposure of the intestines is prevented. For the purpose of avoiding exventration and its evil consequences in cases of intestinal obstruction with great distension of the abdomen, Madelung* has recently described a new method of dealing with the distended intestines. He makes a comparatively small incision through the median line and brings the first distended knuckle of intestine that presents itself into the wound and by passing two fixation ligatures through the mesentery near the gut and making traction upon them draws it forward sufficiently far until both limbs of the loop can be ligated with a strip of antiseptic gauze at a point corresponding to the external surface of the wound. The patient is now placed on his side and the prolapsed loop is incised over the convex surface and its contents evacuated. The gauze ligature is slowly loosened so as to prevent flooding of the wound with intestinal contents by too forcible escape of the fluid contents. When the spontaneous escape ceases a Nélaton's catheter is introduced into the incised bowel for the purpose of facilitating the escape of intestinal contents. Fifteen minutes are spent in efforts aimed at evacuation of the distended paretic intestine during which time anæsthesia is suspended in order to effect still further evacuation of the bowel above the seat of obstruction by the contraction of the abdominal muscles. After all discharge has ceased the visceral wound is cleansed and sutured and the ligatures on each side of the wound are tied so as to prevent undue tension upon the sutures after the gut has been replaced. The ligatures are left hanging out of the wound to serve as guides to the incised part of the gut after the completion of the intra-abdominal examination. The abdominal incision is now enlarged and the intestine drawn forward and careful search made for the obstruction. If this is not found the incised loop of bowel is brought into the wound, the sutures of the visceral wound and the two ligatures removed, and an artificial anus established by stitching the intestinal wound to the margins of the external wound, and the portion which is not required for this purpose is sutured. While Madelung's procedure cannot fail in facilitating exploration of the abdomen by diminishing intra-abdominal pressure it is questionable if the room thus gained is a sufficient recompense for the time lost and

* Zur Frage der operativen Behandlung der inneren Darmeinklemmungen. Archiv f. Klin. Chirurgie, B. XXXVI, p. 283.

the additional risks incident to an intestinal wound in a place where it is not required. If a laparotomy is decided upon in the treatment of an intestinal obstruction it is made for the distinct purpose of finding and removing the obstruction, hence if the patient's strength is such as to warrant this treatment at all, the surgeon should not close the abdomen with the principal object of the operation unaccomplished. How difficult it is to find the obstruction in some cases is well shown by Madelung, who in several cases where the seat of obstruction could not be located during life requested the pathologist when he made the post-mortems to locate the obstruction by introducing his hand through an incision, allowing him from ten to twenty minutes for the exploration ; in every instance he failed to find or locate the obstruction within the specified time. Where the ordinary methods of examination through an incision large enough to permit the introduction of the hand prove themselves inadequate in locating the obstruction, after a search of from ten to twenty minutes it is useless and unwise to persist in pursuing the same course. Such cases should be dealt with by resorting to exventration. This method of exploration was first suggested by Harber in 1872, and practised by Kümmel* in 1885. The large incision which he advocates is necessarily followed by prolapse of the distended intestine and enables the surgeon to examine rapidly and accurately every portion of the intestinal canal with a view of locating the obstruction with little or no risk of inflicting injury during the examination. The greatest objection that has been urged against it is that it is sometimes exceedingly difficult to replace the intestines even after the cause of obstruction has been removed, as the paretic intestines are slow in regaining their normal peristaltic action, and that during the attempts at replacement the intestines are often injured. The proper way to effect replacement is to follow Kümmell's advice and instead of making direct compression to resort to protection of the intestines by covering the whole mass with a warm moist aseptic compress, the margins of which are tucked in under the abdominal incision ; in this way the bowels are protected against the injurious effects of irregular direct pressure and are guided back into the abdominal cavity as the wound is closed by tying the sutures already in place from above downwards. If uniform, diffuse, gentle pressure fails in replacing the intestines then the margins of the abdominal incision should be lifted with blunt hooks, an expedient which renders material aid in effecting replacement. Should the obstacles be so great as to frustrate all attempts at

* Ueber Laparotomie bei innerer Darmeinklemmung. Deutsche Med. Wochenschirft, 1886, No. 12.

replacement it is better to resort to incision and evacuation of the most distended portion of the prolapsed bowel which can be done with greater safety and more marked effect than by the plan devised by Madelung. This is well illustrated by a case that recently came under my observation which I will report in brief.

The patient was a woman forty-eight years of age, the mother of eight children, the last being an infant ten months old. She stated that she had suffered during the last year from constipation, but had always been promptly relieved by cathartics. Ten days before her admission into the Milwaukee Hospital, April 18, 1888, symptoms of acute intestinal obstruction appeared which increased in intensity until fæcal vomiting supervened the day before she came under my observation. She had been treated by high injections and irrigation of the stomach, the former without any effect, the latter afforded great relief. The patient was well nourished and her general appearance gave rise to no suspicion of malignant disease in any of the organs. She had passed nothing per viam naturalis since she was taken ill, and the retching and vomiting were persistent. The abdomen was uniformly and enormously distended; upon the surface of the abdominal wall the outlines of some distended coils of intestine could be distinctly outlined. The tympanitic distension of the abdomen interfered with respiration, the respiratory movements being shallow and rapid, lips cyanosed and extremities cold. Examination per vaginam and rectum revealed nothing as to the seat and nature of the obstruction. Percussion and palpation of the abdomen yielded the same negative results. Laparotomy was performed under the most careful antiseptic precautions. The stomach was irrigated and chloroform used as an anæsthetic. The operation was performed with the patient upon a rubber bed filled with hot water. The first incision was made half way between the umbilicus and pubes and large enough to permit the introduction of the hand. As soon as the peritoneal cavity was opened a loop of small intestine distended to three times its natural size and intensely congested presented itself. This was pushed aside and similar loops made their appearance. I now introduced my hand and found that the cæcum and entire colon were also enormously distended which satisfied me that the obstruction must be located low down in the colon, or the upper part of the rectum; but the most careful attempts by manual exploration failed in furnishing any clue as to the location or nature of the obstruction. The incision was enlarged upwards an inch above the umbilicus and downwards to the pubes for the purpose of effecting complete exventration. Two assistants caught the intestines as they prolapsed in warm moist aseptic compresses, and as the

abdominal cavity was nearly empty I could explore with ease the sigmoid flexure, which I had reason to believe was the seat of the obstruction; as this part of the colon was also greatly distended, I had to proceed lower down with my exploration and finally found a circular carcinoma below the sigmoid flexure in the pelvic cavity near the junction of the colon with the rectum. As resection in this locality was impossible and for the same anatomical reasons an anastomosis could likewise not be made, I was forced to establish an artificial anus. In examining the colon with the view of the best locality for making a colostomy, I found that the enormous dilatation of this part of the intestine had resulted in such an elongation as to force the transverse colon in a downward direction nearly as far as the brim of the pelvis. I made an incision in the left inguinal region above Poupart's ligament two inches in length and sutured the parietal peritoneum to the skin. Into this incision a loop of the displaced transverse colon was pushed by the hand within the abdomen and fixed by a number of sutures. When this was done I attempted to replace the intestines, but after trying all the ordinary devices I had to abandon the attempt. The patient was now placed on her side, and one of the most distended loops was grasped, held over a basin, and punctured with a trocar, while the remaining intestine remained covered with the warm compresses. As the escape of gas and fluid fæces through the cannula was very slow, an incision an inch and a half in length was made in the gut. As the intestine did not contract the escape of contents was very slow, and I had to resort to pouring out of the contents, as it were, by seizing the gut several feet above and below the incision and elevating it, a large quantity of fluid fæces was literally poured out. When no further evacuation could be effected the visceral wound was closed by the continued suture, and after the loop was thoroughly disinfected the bowels were returned without further difficulty. The abdominal incision was closed in the usual way, only that I added two tension sutures as a matter of precaution. After the abdominal wound was closed and dressed, the colon that had been stitched into the inguinal wound was incised and the margins of the incision separately stitched to the sides of the external wound. A considerable quantity of gas and fluid fæces escaped. The vomiting ceased after the operation and the patient rallied under the effects of stimulants. The abdominal distension had diminished greatly the next day, and disappeared almost completely on the second day. The patient's general condition continued to improve until the tenth day after the operation when symptoms of collapse set in which persisted until she died on the following day. The post-mortem showed that the median

incision had healed with the exception of the skin, and that the artificial anus had served as a perfect outlet to the intestinal contents. Small intestines restored to their normal size, and incision healed, the fine silk suture being completely embedded. The cause of the recent diffuse septic peritonitis was traced to perforation of a small abscess behind the carcinoma. The constriction caused by the carcinoma had reduced the lumen of the bowel so much that it was only permeable to the tip of the little finger.

I shall refer again to the subject of chronic causes giving rise to acute obstruction. This case also illustrates the importance of establishing the artificial anus, when such a procedure cannot be avoided, not in the laparotomy wound, but in the right or left inguinal region. When exventration is practised it is essential to furnish the prolapsed and dilated intestine with an artificial covering which should act as nearly as possible as a substitute for the abdominal parietes. This is best accomplished with warm compresses in the hands of one or two reliable assistants. After the surgeon has found the obstruction it becomes necessary to demonstrate the permeability of the remaining portion of the intestinal canal, as it has happened that after a successful removal of an obstruction that patients have died because a second obstruction was overlooked. Of course in such cases the search for additional obstructions must be extended below the obstruction which has been found and removed. An infalliable test for ascertaining the permeability of the remaining portion of the intestinal canal is furnished by rectal insufflation of hydrogen gas. In cases where after exventration it is not possible to find the obstruction by examination of the distended portion of the intestine, the contracted empty portion below the obstruction can be brought into sight by the same means and a search for the obstruction made from below upwards by examining the bowel as it becomes inflated until the seat of obstruction is reached.

Operative Treatment of the Obstruction.

I. *Intestinal Anastomosis.*

What shall be done if the obstruction cannot be found after all diagnostic resources have been exhausted? Shall we establish an artificial anus and leave the patient to the inevitable fate of remaining a sufferer from this loathsome condition the balance of his lifetime should he recover from the operation? Under such circumstances the surgeon assumes a great responsibility in establishing an artificial

anus high up in the intestinal canal, even as far as the immediate effects of the operation are concerned. The paretic bowel below the seat of the artificial outlet unable to empty itself of its contents constitutes an immediate and remote source of danger, as it leaves that portion of the bowel between the new opening and the obstruction in the same condition as before the operation, and permanent exclusion of a considerable portion of the intestinal canal alone may subsequently destroy life by progressive marasmus. In such cases I should advise the following plan of treatment. The empty bowel below the seat of obstruction, if not already found, should be inflated with hydrogen gas per rectum and the highest portion of the inflated bowel drawn forward into the wound and two rubber bands passed through its mesentery about four inches apart and held in place by an assistant. The surgeon now locates as near as he can the lowest portion of the bowel on the obstructed side, which is also brought forward into the wound and similarly secured. The bowel on the proximal side is incised on the convex surface to the extent of an inch and a half; through this incision the contents are evacuated as far as possible, after which all the four rubber bands are tied and the bowel on the distal side incised in a similar manner. Into each of these incisions a decalcified perforated bone plate is inserted, and with the lateral suture armed with a round needle the margin of the wound on each side is transfixed. After the plates and sutures are in place the loops are thoroughly disinfected and the serous surfaces to the extent of the size of the plates are lightly scarified with the point of a needle, when the wounds are placed *vis a vis*, and the corresponding four threads tied together with sufficient firmness to secure perfect coaptation of the serous surfaces. The sutures are cut short and their ends buried as deeply as possible by pushing them in between the approximated bowels with a director or blunt scissors. A few superficial stitches of a continued suture will enhance the safety of the operation. In this manner an anastomosis is established with the exclusion of probably only a small portion of the intestinal tract. After uniting two intestines by approximation plates in the formation of an intestinal anastomosis it appears at first sight as though on the slightest distension of the intestines leakage of gas or fluid contents would take place between the serous surfaces. That this fear is unfounded I have satisfactorily proved by a number of experiments. The intestines of animals recently killed were used and an anastomosis made between the lower portion of the ileum and the colon. The colon was tied below the new opening and fluid forced into the ileum on the proximal side. The pressure was measured by a mercury gauge. It was found that no

leakage occurred under a pressure of two pounds to the square inch continued for thirty seconds. As even in cases of great intestinal distension the pressure can never reach this degree; leakage from mechanical or physical causes will never take place from the new opening. The margins of the visceral wounds act like valves, and when the serous surfaces are kept in contact by the plates prevent the escape of gas or fluids into the peritoneal cavity. The safety and practicability of this operation I have abundantly demonstrated by my experiments on animals and by a number of operations on the human subject. The operative treatment of the obstruction will depend upon the location and nature of the obstruction. If it is decided not to remove the obstruction either on account of its intrinsic harmless character, aside from its mechanical effect, or, on account of its extent, in which case the removal would be an imminent source of danger to life, or if after removal a recurrence in the near future appears inevitable, an anastomosis is established between the intestine above and below the obstruction by lateral apposition with decalcified perforated bone plates. By this operation the continuity of the intestinal canal is restored with permanent exclusion of the seat of obstruction. In cases of cicatricial stenosis as a cause of obstruction, intestinal anastomosis, for instance, would be a vastly more safe operation than resection and circular enterorrhaphy, and would secure equally well the restoration of the continuity of the intestinal canal. In cases of carcinoma of the intestine with extensive infiltration of the lymphatic glands a resection followed by circular enterorrhaphy must always constitute a hazardous procedure, and even if it proved successful an early recurrence of the disease would be inevitable. Under such circumstances it is advisable to establish in preference an intestinal anastomosis which will effectually exclude the cause of obstruction, alleviate suffering and prolong life. The opponents of laparotomy in cases of acute intestinal obstruction have urged as one of the principal reasons for their opposition that the dilated inflamed intestine above the obstruction is not in a condition to undergo reparative processes when the operation demands a solution of continuity in this part of the intestinal tract. Circular enterorrhaphy under such circumstances is a very dangerous procedure for two reasons: 1. It becomes necessary to unite bowel ends of unequal size. 2. The inflamed intestine has undergone textural changes illy adapted for suturing as the sutures readily cut through the softened tissues. A number of clinical observations have satisfied me that the failures which have attended circular enterorrhaphy in such cases are not due to a lack of healing capacity on part of the inflamed end of the bowel, but to the mechanical difficulties which are

encountered in the approximation and retention of the bowel ends, and the danger of the cutting through or yielding of the sutures. I believe on the contrary that in case septic peritonitis does not exist, the vascularity of the bowel above the seat of obstruction constitutes a favorable condition for rapid union. To demonstrate the correctness of this assertion, I made the following experiments:

Experiment 1.—Dog, weight 14 lbs. The whole abdomen was shaved and thoroughly disinfected, and while the animal was under the influence of ether a small incision was made in the left iliac region, and a loop of intestine drawn forward and ligated with a band of iodoform gauze, the ligature being tied with sufficient firmness to cause complete occlusion, intestine returned and wound sutured. Seventy-three hours later the dog was again etherized and median laparotomy performed. Distended vascular loops of the intestine came into the wound, which were pushed aside and the hand introduced, which being passed towards the left inguinal region at once came in contact with the ligated portion which had formed adhesions to the parietal peritoneum and neighboring intestinal loops. The adhesions were separated and the ligated loop drawn out of the wound. Above the ligature the bowel was at least one and a half times larger than immediately below the seat of obstruction, very vascular and contained gas and fluid fæces. The degree of dilatation diminished from below upwards. The seat of obstruction was eight inches above the ileo-cæcal valve, and the gauze ligature was covered with a thick layer of plastic lymph. The obstruction was left and the continuity of the intestinal canal restored by an ileo-colostomy with perforated decalcified bone plates. The animal, which was not vigorous before the experiment was made, appeared much prostrated and died twenty-four hours after the operation. The necropsy showed that the bowel above the constriction had to a great extent recovered its normal size and color. The two intestines where anastomosis was made were firmly adherent, the groove between them corresponding to the length of the plates filled in with plastic lymph. New opening permeable; no leakage at point of operation under hydrostatic pressure. No peritonitis.

Experiment 2.—Dog, weight 24 lbs. Obstruction produced in a similar manner as in preceding experiment. Seventy-five hours later operative treatment of obstruction by laparotomy. The seat of obstruction was again readily found by manual exploration of the abdomen. Bowel above seat of constriction at least twice the normal size and highly congested. Peristaltic action sluggish, responding very slowly and imperfectly to mechanical irritation. Gauze band buried under a ring of plastic lymph, which bridge-like united the gut below

and above the constriction. As the obstruction was located about the middle of the ileum an ileo-ileostomy by lateral apposition with decalcified perforated bone plates was made leaving the gauze band undisturbed. The incision into the bowel above the seat of obstruction showed that all the coats were thickened and softened, while below the obstruction only the mucous membrane was in a state of catarrhal inflammation. About eight inches of the bowel including the seat of constriction were excluded by the operation. The animal showed no signs of suffering or illness after the operation, and when killed after the expiration of twenty-one days was in excellent condition. During this time the appetite was good and fæcal evacuations normal. Gauze band completely encapsuled, and close to it an acute flexion of the bowel; excluded portions adherent along convex surface to each other; bowel above constriction about one-third larger than below. New opening admits the tips of two fingers.

Experiment 3.—Dog, weight 28 lbs. Laparotomy seven days after complete obstruction had been caused by ligation of small intestine with gauze band through a small wound in the left inguinal region. Tympanites moderate. Obstruction found sixteen inches above the ileo-cæcal region. Peristaltic action almost suspended in bowel above obstruction,—normal below. Intestine above the constriction dilated to twice its normal size, exceedingly vascular, containing solid fæcal masses, fluid fæces and gas; below, empty, contracted and anæmic. Exclusion of six inches of the intestine at seat of obstruction and restoration of continuity of intestinal canal by ileo-ileostomy with decalcified perforated bone plates. After operation function of intestinal canal normal and appetite good. Killed eight days after operation; no peritonitis: adhesion of omentum to line of abdominal incision; gauze band completely covered by a plastic exudation; a number of adhesions between adjacent intestinal loops. Point of operation situated in the center of a horse-shoe shaped loop of intestine which was found to be the excluded portion. Intestine above obstruction about one-fourth larger in size than below. Excluded portion of bowel empty. At seat of anastomosis a mass of straw and hair had accumulated on proximal side. New opening large enough to admit two fingers.

Experiment 4.—Dog, weight 34 lbs. Complete obstruction of small intestines by ligation with gauze band through a small wound in the left iliac region. Operative treatment by laparotomy 120 hours later. This animal vomited several times shortly before the operation. Bowel at seat of obstruction adherent to adjacent intestines. Obstruction readily found and brought into the incision. Intestine above con-

striction twice its normal size, dark purple in color, tissues swollen and very much softened. Below constriction bowel empty, collapsed, pale, and only the mucous membrane in a state of catarrhal inflammation. The dilated bowel contained gas and fluid fæces. Peristaltic action in this part nearly suspended, the response to mechanical irritation being slow and imperfect. Below the obstruction, function of bowel unimpaired. As the occlusion was only four inches above the ileo-cæcal valve, it was found impossible to limit the anastomosis to the ileum consequently the continuity of the bowel was restored by an ileo-colostomy, uniting the ileum just above the obstruction with the colon above the cæcum, using the perforated approximation plates. The gauze band was left *in situ*. The animal showed no untoward symptoms after the operation, and was killed twenty-one days later. During this time appetite was good and intestinal function normal. A number of adhesions were found at site of operation between adjacent intestinal loops. Gauze band completely encysted. Some crude material, as straw, hair and fragments of bone was found on the proximal side of new opening. Anastomotic opening large enough to admit tips of two fingers; union between approximated portions of intestine so complete that it presented all around the appearance as though their peritoneal surfaces were continuous.

These experiments show conclusively that in acute obstruction even after seven days the bowel above the obstruction is capable of undergoing a rapid reparative process and that adhesive union takes place as early, if not earlier than, in operations upon a normal intestine. The experiments likewise prove the greater safety of anastomosis by lateral apposition with decalcified perforated bone plates than of resection and circular enterorrhaphy in restoring the continuity of the intestinal canal. Anastomosis, after resection for intestinal obstruction, can be made in the same manner between the proximal and distal part after the resected ends have been closed by invagination and a few stitches of the continued suture as when the obstruction is not resected but excluded.

In cases of congenital atresia of the small intestines most frequently met with in the upper portion, anastomosis should always take the place of circular resection, as the operation can be done in less than twenty minutes, an exceedingly important matter as far as the immediate effects of the operation is concerned in infants, at the most only, a few days old. In cases where such a congenital defect is suspected the abdomen should be opened in the median line, being careful not to cut through the umbilicus, when the seat of obstruction can be readily and rapidly located by inflation of the stomach and rectum with hydro-

gen gas. It is necessary to inflate from both directions, as in some cases the atresia is multiple. In cases of cicatricial stenosis of the pylorus a gastro-enterostomy by lateral apposition with approximation plates is a safer operation than resection, or the procedures recommended by Loretta and Mikulicz, while the functional result is equally, if not more, satisfactory. In carcinoma of the pylorus, where resection is contra-indicated on account of the extent of the disease, or its extension to neighboring organs, or because glandular infection has taken place, suffering can be diminished and life prolonged by making a gastro-enterostomy, substituting for the tedious double suturing as advised by Wölfler the perforated approximation plates. During the last year I have made four such operations and with such satisfactory results so far as the operation is concerned that I am induced to report them in this connection with the hope that others may give this method of operating a trial in similar cases. I have made it a rule that the patient should abstain from taking food by the stomach for at least twenty-four hours before the operation, and rely for a few days, at least, entirely upon rectal alimentation, allowing by the mouth only pieces of ice to quench thirst. The operations were performed as follows: The evening before the operation the stomach was washed out by the syphon tube and again just before the anæsthetic was administered. For the last irrigation a five per cent. solution of salicylate of soda was used. In all of these cases the incision was made through the median line and extended from near the ensiform cartilage to the umbilicus. The opening in the stomach was made parallel to the long axis of the organ and at least an inch and a half distant from the margin of the tumor. A continued suture of fine silk was applied around the whole circumference of the opening both for the purpose of arresting hæmorrhage and preventing bulging of the mucous membrane. In the intestine the opening was made between two rubber ligatures so as to prevent any extravasation of intestinal contents and the margins of the wound were sutured in a similar manner. The opening in the intestine was made first and the plate introduced and sutures adjusted and the loop retained in the lower angle of the wound, covered by a warm compress. The large curvature of the stomach near the pyloric orifice was then drawn sufficiently forward into the wound to make the incision and introduce the plate. When everything was ready for adjustment, the parts around the visceral wound were carefully disinfected, dried and the serous surface lightly scarified with an ordinary needle over a surface corresponding to the size of the plate ; the new openings, (wounds) were then brought opposite each other and a fine silk suture, embracing only the serous and muscular coats, was applied

behind the lower middle-plate-suture and tied; the middle lower suture was now tied, while an assistant approximated the two openings, the lateral sutures were next tied, and lastly the anterior middle. The sutures were all cut short and ends buried. During the tying of the sutures, it is necessary to exercise caution that the margins of the visceral wound are well embraced by the plates all around. As in these cases the weight of the intestine exerts considerable tension, I have taken the precaution in my two last cases to apply a superficial continuous suture anteriorly after tying the four sutures so as to approximate the serous surfaces over the anterior margins of the plates. The necessary preparations made, and with good assistance, the operation can be finished in from twenty to thirty minutes. Neither shock nor peritonitis was observed in any of the cases. Usually on the third day small quantities of peptonized milk and beef tea were given at short intervals and solid diet during the second week.

Case I.—Male, aged sixty-five. Symptoms of pyloric stenosis for one year. Emaciated to a skeleton; oedema of legs; unable to retain food of any kind for more than a few hours. The patient was so anæmic and prostrated that he was only partially anæsthetized. During the operation the pulse became almost imperceptible, and brandy had to be administered subcutaneously with lowering of head, and hot applications externally. An hour after the operation the pulse was stronger than before it was commenced. Rectal feeding; only slight rise in temperature on second day; no pain. On the third day small quantities of liquid food by the stomach. The heart's action gradually failed and the patient died of marasmus five days after the operation. The post-mortem revealed that the plates were still in situ, adhesions firm and opening patent. No peritonitis. In this case the carcinoma was circular and limited to the pylorus. Anastomosis just below the duodenum. The intense suffering had made the patient desperate, and although the nature of the disease and the probable outcome of the operation had been fully explained to him, he begged to have it done, with a perfect understanding that at best it would afford only temporary relief. I am quite confident that the operation did not shorten his life.

Case II.—Male, aged forty-seven. Duration of disease, eighteen months; obstinate vomiting; great emaciation and œdema of the legs. Contour of tumor could be readily mapped out by percussion and palpation. Tumor adherent to under surface of liver; enlargement of lymphatic glands. In this case the anastomosis was again made just below the duodenum. No untoward symptoms after operation. At

the end of the first week solid food was allowed. No vomiting. At the end of the third week an abscess formed in the upper part of the healed incision, in the contents of which, the plate ligatures were found. A gastric fistula formed through which food escaped almost immediately after it was swallowed. This closed in less than two weeks. After which the patient improved in strength and gained in weight. He retained and digested all kinds of food. Improvement continued so that he was able to walk short distances and to take long drives. At the end of three months after the operation he commenced to fail and died two weeks later of progressive marasmus. Unfortunately no post-mortem could be obtained.

Case III.—Man, aged thirty-five. Symptoms of pyloric stenosis for six months. Tumor discovered four months ago rapidly increasing in size. Considerable amaciation and cachectic appearance. Tumor involves nearly one-third of anterior wall of stomach and the entire pylorus. Glands of omentum infiltrated. The first loop of intestine which came within reach was united with the anterior wall of stomach in the usual manner. Sutures of abdominal wound removed on the eighth day. Until this time no untoward symptoms, although the patient had taken liquid food for several days. The day following obstinate vomiting occurred; the plates, very much softened and greatly reduced in size, were ejected. The stomach was repeatedly irrigated, but vomiting continued until the patient died three weeks after the operation. Post-mortem: Abdominal incision united throughout; omentum, stomach and intestines adherent to abdominal incision. Anastomosis perfect at a point eight feet below pylorus. Intestine between pylorus and artificial opening enormously distended. As the opening was large enough to admit two fingers it was difficult to understand what had caused the obstruction. The pyloric orifice was large enough to admit the tip of index finger. Fluid could not be forced from the stomach into the bowel below the new opening. Injection through the duodenum was made with the same negative result. On close examination it was found that the intestine at the point of anastomosis, probably on account of the great length of the part between the stomach and the new opening, had become flexed at the point where it was attached to the stomach, and the two limbs were adherent to each other for four inches. This bending of the bowel had formed a spur opposite to the opening in the stomach by the apex of the concave side of the bowel, and this spur acting like a valve closed the opening in the distal part of the bowel when water was injected into the stomach or duodenum.

This case taught me that it is unsafe to follow the advice given by Luecke and others to seize the first presenting loop for the anastomosis, as by so doing, it is possible to grasp a loop of intestine which corresponds to the lower portion of the small intestines, as in this case, and if this is done we not only exclude permanently too great a portion of the intestinal canal from the processes of digestion and absorption, but a similarly unfortunate mechanical difficulty at the new opening may be created as has been described above.

Lauenstein recently reported a case of gastro-enterostomy where the post-mortem revealed that the new opening was made near the ileo-cæcal region. In making a gastro-enterostomy it is important for the reasons just cited to follow the advice of Hahn and search for the duodenum, which when found can be readily recognized by its short and fixed attachments, and to make the new opening in the upper part of the jejunum as near as possible to the duodenum.

Case IV.—Man, aged forty-three. Has complained of stomach difficulty for a year. During the last two months obstinate vomiting an hour or two after meals. Tumor as large as a child's fist; movable. Emaciation and marked anæmia; glandular infection behind the stomach. Anastomosis made just below the duodenum. Very little pain, and no other symptoms until the tenth day, when he vomited several times. Stomach washed out twice, four hours apart, and food by the stomach discontinued. No vomiting after this, and after two days a liquid diet ordered. At the end of the second week could digest all kinds of solid food which caused no distress. On the thirteenth day fragments of both plates were found in one of the stools. Patient has gained in flesh and presents a great deal better appearance at this time (four weeks), than before the operation.

These cases have satisfied me that gastro-enterostomy in cases of inoperable carcinomatous stenosis of the stomach is a safe and justifiable operation and should be more frequently resorted to, as it is the only resource which promises substantial relief, prolongs life and infuses new hope in a class of patients otherwise doomed to a speedy death without a ray of hope.

II. *Physiological Exclusion by Anastomosis.*

In some cases of intestinal obstruction the restoration of the continuity of the intestinal canal by resection and circular enterorrhaphy would necessitate the removal of several feet of the intestine where the cause of obstruction in itself constitutes no intrinsic source of

danger, and where recovery would be more likely to take place by the substitution of anastomosis for resection. That resection of a number of feet of the small intestines is not always compatible with health is well illustrated by a case reported by Baum, in which he removed 137 ctm. in a woman forty years of age. The patient was suffering from strangulated femoral hernia. Taxis was only partially successful. On opening the sac an offensive fluid escaped, and a portion of the omentum was removed. Peritonitis followed and a swelling formed in the abdomen above the crural ring, which broke and a fæcal fistula formed; rapid emaciation ensued, symptoms of strangulation made a laparotomy necessary. A mass of intestine was found twisted into a bunch which could not be unravelled, and as it was surrounded by an abscess it was resected and the ends united with sutures. Patient recovered from operation and improved for several weeks. Six months later progressive marasmus resulted in death. The autopsy revealed no other cause of death except marasmus from too extensive resection. In such a case I would propose that the twisted adherent intestinal coils, the cause of the obstruction, if they present no evidences of gangrene, should be left and permanently excluded from the fæcal circulation by making an anastomosis with approximation plates between the bowel leading to and from the obstructing mass. A case somewhat similar to Baum's, but under less favorable circumstances, came under my care during the last year where this plan of treatment was adopted.

Strangulated Hernia: Resection of Gangrenous portion: Additional Obstruction by a mass of adherent intestinal loops: Restoration of Continuity of Intestinal Canal by Anastomosis.—The patient was a brewer, thirty years of age, who had had an inguinal hernia for several years, but never wore a truss. On lifting a heavy weight the swelling became suddenly enlarged, followed by symptoms of acute strangulation. The attending physician overlooked the hernia and treated the patient for gastritis. Eight days after the attack he was admitted into the Milwaukee County Hospital. At this time symptoms of acute diffuse peritonitis were well marked. Pulse rapid and feeble; extremities cold; abdomen tympanitic and excessively tender on pressure. Stercoraceous vomiting. Hernia as large as a child's fist, skin covering it discolored and œdematous. It was plain enough that gangrene had occurred, and that in consequence of this peritonitis had developed. The patient was given $\frac{1}{120}$ of a grain of atropia hypodermatically before chloroform was administered. On opening the sac fæcal matter escaped and a large mass of discolored omentum presented itself. The sac was irrigated with a weak solu-

tion of sublimate, and the omentum drawn forward and wrapped in a small compress of gauze. The entire loop of intestine was gangrenous and perforated on the convex surface at its highest point. The parts were again irrigated before the inguinal canal was laid open by incision. The omentum was now drawn downward until a healthy portion was reached, when it was ligated in several parts and cut off. The intestine was separated from its attachments to the inguinal canal and the gangrenous part about eight inches in length excised after having previously guarded against fæcal extravasation by applying a rubber ligature on each side. Examination of the abdominal cavity at this time showed recent peritonitis. In drawing down the proximal end of the gut it was found that it was but little distended, hence search was made for an additional obstruction higher up, which was found in the shape of a mass of intestinal coils twisted in every conceivable shape and so firmly adherent that all attempts at unravelling had to be abandoned. The intestine above this point was enormously distended, showing that the bunch of adherent intestines had caused a second obstruction. Excision of three to four feet of intestine, under these circumstances, was not to be thought of as the patient would certainly have died on the table. Should I leave the cause of obstruction and establish an artificial anus on the proximal side? I decided to leave the obstruction and establish a communication between the intestine on the distal and proximal side of the obstruction. Both resected ends were closed by invagination and a few stitches of the continued suture. By lateral apposition with decalcified perforated bone plates an anastomosis was established between the distal collapsed end and the dilated bowel on the proximal side of the obstruction. Before the approximation sutures were tied the intestinal contents were evacuated as far as possible. The whole peritoneal cavity was flushed with sterilized water, carefully dried, drained, and the wound sutured. The toilette of the peritoneum was made with a sponge wrung out of a 1–2000 solution of sublimate. The hernial sac was excised and the stump fastened in the inguinal canal by the deep sutures used in closing the external wound. Duration of operation less than an hour. The patient rallied from the operation, but succumbed to the peritonitis at the end of twenty-four hours. Post-mortem: On removing the sutures the sac walls were found agglutinated by plastic lymph. Drainage tube surrounded by a thick layer of plastic lymph, and coils of intestine which completely shut out the abdominal cavity. Only about half of the omentum remained. The part of intestine where anastomosis was made was found in the pelvis lying against the concave surface of the sacrum, surrounded by

numerous recent adhesions. The new opening was twelve inches above the ileo-cæcal valve; adhesion between the serous surfaces, held in approximation by the plates, was sufficiently firm to prevent leakage under strong hydrostatic pressure. Opening patent.

My experiments on animals related in the paper previously referred to have demonstrated that physiological exclusion of a certain portion of the intestinal tract is a less dangerous operation than excision. The appearances of the specimens also tend to prove that so long as any of the contents of the intestines reach the excluded portion, the peristaltic, or anti-peristaltic action in that part is effective in forcing it back into the active current of the fæcal circulation. If the excluded portion again becomes permeable it resumes its physiological function and again takes an active part in the processes of digestion and absorption; if the obstruction remains permanent it undergoes progressive atrophic changes.

III. *Laparo-Enterotomy.*

Incision of the bowel for the removal of obstruction during laparotomy is indicated when the obstruction is due to the presence of a foreign body, a concretion, an enterolith, or a pedunculated benign polypoid tumor. In the removal of a foreign body, a concretion, or an enterolith, not amenable to removal by submural crushing, or fragmentation with a needle, the incision for extraction should not be made over the seat of impaction, as this part of the intestine has undergone changes unfavorable to the satisfactory healing of the visceral wound. It is much better in such cases to make the incision in a healthy part of the intestine an inch or two below the impaction, and then crush the foreign body by instruments introduced through the incision. The removal of a non-malignant pedunculated polypoid tumor is to be accomplished by making an incision on the convex surface of the bowel large enough to admit of dragging the tumor through it, after which the base of the pedicle is transfixed by a double ligature and tied, the tumor cut off and the wound closed in the usual manner.

IV. *Enterectomy.*

Enterectomy is indicated when the obstruction is due to a malignant tumor if it is possible to remove the disease completely, also for the removal of benign tumors which cannot be excised by enterotomy, and in all cases where gangrene has been caused by constriction, compression or over-distension. Carcinomatous stenosis is met with

most frequently in the large intestines, while the causes which result in gangrene are most common above the ileo-cæcal valve. For malignant disease resection should be done if the entire tumor and all infected glands can be removed completely and with safety. Even, if on account of loss of substance circular enterorrhaphy cannot be made in such cases, the continuity of the intestinal canal can be restored by lateral implantation, or by lateral opposition with decalcified bone discs. Immediate circular enterorrhaphy after resection for intestinal obstruction has always been attended by a great mortality for reasons mentioned elsewhere. In a series of thirty-five resections of the large intestines which Weir collected when symptoms of obstruction indicated the operation the mortality amounted to one hundred per cent. Reichel* has also shown that resection of the small intestines for conditions giving rise to obstruction, gave a mortality of 75 per cent., whereas in secondary resection for an artificial anus the mortality is reduced to 37 per cent., a statement which is supported by Makins† in his report of 15 deaths, in 39 resections for artificial anus. If after the resection is made, a primary circular enterorrhaphy is not made, Hahn recommends, so as to preserve the advantages of a clean wound and yet to allow the escape of fæces, that the intestine should be closed tightly around a rubber tube, which is left projecting some distance for this purpose. In the removal of a tumor of the cæcum with partial resection of the intestinal wall it may be advisable to follow the example of Porter,‡ in restoring the continuity of the intestinal canal by suturing. In his case a part of the circumference of the cæcum including a portion of the ileo-cæcal valve was resected for the cure of a fæcal fistula. The wound was closed by slitting up a portion of the ileum from the seat of resection and uniting the margins of this wound with the resected surface of the cæcum. The patient recovered. In cases where the lumina do not correspond it is advisable to follow the suggestion first made by Wehr in performing pylorectomy, viz : to cut the end of the narrower part of the bowel not transversely, but sufficiently oblique so that the circumference of the oblong opening will correspond to the lumen of the larger end of the bowel. The obliquity should always be made at the expense of the convex portion of the bowel, so as to interfere as little as possible with the vascular supply from the mesenteric side. Madelung in

* Kasuistische Beiträge zur cirkulären Darmresektion und Darmnaht. Deutsche Zeitschrift f. Chirurgie, B. XIX, Heft 2 u 3.

† Med. Chir. Transactions, vol. lxvi.

‡ Excision of a portion of Intestine, including Part of the Ileo-cæcal valve, for the Cure of Fæcal Fistula in right Groin. Boston Med. and Surg. Journal, May 15, 1884.

resecting the bowel makes his incisions somewhat obliquely in the same direction for the purpose of guarding more affectively against gangrene on the convex side of the bowel after circular enterorrhaphy. In such extensive resection of the colon where the possibility of circular suturing is precluded on account of the impossibility of approximating the cut ends, an artificial anus should never be established, as no subsequent treatment could restore the continuity of the intestinal canal. Two such cases were recently reported by Hahn. It is possible that, in the future, experimental research will prove the practicability of restoring such defects by a plastic operation consisting of transplantation of a corresponding portion of the small intestines between the separated ends, a procedure which would necessitate circular suturing—at three different points. Until it has been shown that some such plan is feasible the surgeon must content himself in establishing an anastomosis between the proximal and distal ends by lateral apposition with decalcified perforated bone plates. The latter procedure offers all the advantages to be derived from approximation and keeping in uninterrupted coaptation a large serous surface with immobilization of the parts it is intended to unite during the process of repair. In circumscribed gangrene, due to decubitus and involving not more than one-half of the circumference of the bowel, affecting its lateral or convex surfaces, such as is caused by constriction by a narrow band, resection is not necessary. After the constriction has been removed, the gangrenous spot is turned inward and is covered by suturing the adjacent healthy margins of the bowel over it. The serous surfaces unite rapidly so that perforation during the separation of the gangrenous part is prevented by union of the serous surfaces over it. When a whole loop or a number of loops of the intestine present evidences of gangrene from constriction the indications for resection are clear as affording the only possible chance of preventing death from sepsis or perforation. Unfortunately in such cases septic peritonitis has usually set in before the operation is performed, and it becomes necessary after the resection has been made and the continuity of the intestinal canal restored by approximation plates to treat the peritonitis by flushing the abdominal cavity with sterilized water and disinfection with some mild antiseptic, as a one-third per cent. solution of salicylic acid as advised by Mikulicz. Drainage in such cases becomes a necessity.

V. *Direct Treatment of Obstruction in Strangulation by a Band or Diverticulum, Flexion or Adhesion, of the Intestines.*

The most favorable cases of intestinal obstruction for laparotomy are those where the obstruction is due to constriction from a narrow ligamentous band. The history of such cases usually points to an antecedent attack of localized peritonitis. One or more of the adhesions during the course of time are drawn out into a band under which the intestine is caught, and strangulation takes place in the same manner as in strangulated hernia. These are the cases of intestinal obstruction which, if left alone, almost without exception result in death; if submitted to an early operation they are cured by one stroke of the scissors. If the strangulated loop presents no evidences of gangrene, and no signs of decubitus are found at the point of compression, the strangulation is relieved by cutting the band, and for the purpose of preventing a recurrence of the strangulation from the same cause it is necessary to trace the band to its points of fixation and resect it between two ligatures. A diverticulum of the small intestines, remnants of the vessels of the vitelline duct, or the appendix vermiformis have often been found as a cause of constriction when the free extremity of these structures had become adherent to some fixed point, and it is always necessary to make a close examination of a constricting band before resorting to cutting instruments, as a mistake in recognizing the true anatomical character of the obstructing cause might lead to serious results. A narrow appendix may be tied and resected the same as a ligamentous band, but when the obstruction is caused by a diverticulum greater care must be exercised in removing the cause of obstruction. Many of the diverticula which have been met with as a cause of obstruction were nearly as large at their base as the intestine with which they were connected, and in such instances it would be unsafe to rely upon a ligature at the resected end in affecting permanent obliteration as cutting through of the ligature might be followed by perforation, and death from septic peritonitis a few days after the apparent recovery of the patient. The proximal end of such a resected diverticulum must be closed with the same care and in the same manner as the ends of the intestine after permanent interruption of its continuity by resection and restored to function by anastomosis. If the obstruction is found to be due to flexion the mechanical difficulty must be corrected by separating the adhesions, as the apex of the flexion is generally if not always adherent to some fixed point; after this has been done the proper shape and contour of the bowel should be restored and its permeability tested by pushing the contents beyond the flexed

part if this can be done without meeting with resistance and if the condition of the intestinal walls at the site of flexion presents no serious textural changes the intestine is returned and the abdominal incision closed. As the concavity of the flexion is usually directed towards the mesenteric attachment the vascular disturbances are most marked on the convex surface of the bowel, and if gangrene or perforation has taken place it is found at this point. In either of these events it would become necessary to liberate the intestine by separating the adhesions and then resort to a "V" shaped excision on the convex side of the intestine. The portion to be excised must be of sufficient size to include the diseased tissue and to enable the surgeon to rectify the malposition after suturing. Immobilization of a considerable portion of the intestinal canal by a large blood clot and extensive parietal and visceral adhesions may give rise to symptoms of intestinal obstruction. When intra-abdominal hæmorrhage is followed by a complexus of symptoms indicative of the presence of intestinal obstruction, the abdomen should be opened and the coagulated blood removed by sponging and flushing of the peritoneal cavity with sterilized water and the recurrence of the same condition prevented by arresting further hæmorrhage. A form of visceral adhesions between coils of intestines massed into a bunch has already been described as a cause of intestinal obstruction. If this condition has lasted for several days and the adhesions have become firm, it is absolutely impossible to unravel the gut without running the risk of inflicting numberless and perhaps irreparable injuries. In such instances excision of the mass, followed by circular enterorrhaphy, or anastomosis between the intestine above and below the obstruction, as previously described, present themselves as the most appropriate methods of treatment. Each of these operations is applicable to special cases and adapted to meet particular indications. Thus if any of the embedded coils should present indications of incipient gangrene resection must be done. If no such textural changes are present intestinal anastomosis should be preferred as by it the obstruction is removed and the portion temporarily excluded, after subsidence of the inflammation and absorption of the adhesions may again become permeable and resume its physiological function. Circumscribed parietal adhesions, as a cause of intestinal obstruction, are most frequently met with in the pelvis, and on account of the greater frequency of pelvic inflammation in the female occur more frequently in women than men. Pelvic intestinal adhesions produce obstruction in two distinctly different ways: 1. An adherent intestine becomes flexed or twisted by the peristaltic action of the free portions and obstruction results from sudden or gradual

stenosis of the lumen of the bowel. 2. A portion of intestine becomes fixed at either end by adhesions and a loop is caught under it when obstruction is caused in the same manner as from ligamentous bands.

The only case of intestinal obstruction after ovariotomy which occurred in my practice was produced in this manner. The pedicle was tied and its surface cauterized. No untoward symptoms until at the end of the third week, when symptoms of intestinal obstruction appeared suddenly and increased in intensity in spite of irrigation of the stomach and high rectal injections. She died two weeks later. The post-mortem showed that a loop of the lower portion of the ileum had become adherent to the surface of the pedicle, and that the mesentery constituted the second fixed point; under this loop, another loop four inches in length had slipped from above downwards and had become incarcerated in this position. The intestine below the obstruction was perfectly empty, while above it, it was enormously dilated and exceedingly vascular as far as the duodenum.

Quite a number of similar cases have been reported by different operators. In old cases of pelveo-peritonitis and salpingitis the cause of a subsequent attack of intestinal obstruction is frequently traceable to intestinal adhesions and the formation of ligamentous bands. In the separation of such old adhesions the greatest care must be exercised not to tear the bowel, as both the parietal and visceral peritoneum may have been transformed into a cicatricial mass which it is not safe to separate by tearing. The separation must be done by careful dissection which for the sake of safety is done rather at the expense of the parietal than the visceral tissues. Defects of the peritoneum thus caused or made during other abdominal operations, should be covered either by suturing, by laying the omentum over it, or, if need be, by omental grafts to prevent a recurrence of such complication. The parietal peritoneum is so loosely attached almost everywhere that it yields sufficiently to cover a defect at least two inches in width by suturing and whenever this can be done it should not be neglected, as surfaces denuded of peritoneum are liable to become permanently adherent to adjacent abdominal viscera. If larger defects are to be covered the peritoneum can be cut in the shape of flaps which can be readily mobilized and sutured. When the omentum is within reach this should be utilized in covering the defect. During the last year I made a number of experiments on animals which demonstrate that when a piece of parietal peritoneum three to four inches square is removed and not restored in some of the above ways, permanent adhesions form between the denuded place and the organ that comes in contact with it. Another series of experi-

ments which it would be too tedious to describe in full were made to show that peritoneal defects which cannot be restored by suturing or covering with the omentum can be treated successfully by transplantation of an omental or peritoneal graft. In some of the experiments I removed from each side of the abdominal wall at corresponding points a piece of peritoneum four inches square and transplanted these pieces to opposite points and sutured them to the margins of the wound with cat-gut. All of these experiments proved successful. Omental grafts answered the same purpose, and in only one instance did the graft fail to unite throughout, and here one of its margins projected into the median abdominal incision which did not unite by primary union. Infection of this margin led to gangrene of the graft and septic peritonitis.

VI. *Toilette of Peritoneal Cavity.*

If everything that has come into contact with the abdominal cavity during a laparotomy for intestinal obstruction has been rendered aseptic by the most scrupulous antiseptic precautions and the local conditions found have caused no infection and no soiling of the peritoneal cavity with intestinal contents has taken place during the operation, the abdominal cavity is aseptic after the operation and can be closed after the removal by gentle sponging of any blood that may have collected. Unnecessary exposure of the intestines should always be most carefully guarded against by compresses around the incision during intra-abdominal exploration, and by keeping the intestines constantly covered by warm compresses as long as they are outside the peritoneal cavity for the purpose of preventing infection by floating microbes and to guard against loss of heat during the operation. The case is, however, entirely different when the parts concerned in the obstruction have caused intra-peritoneal sepsis at the time the operation is undertaken, or when, during its performance in spite of all care to prevent it, the peritoneal cavity has become contaminated by fæcal extravasation. Under these circumstances the peritoneal cavity should be flushed with gallons of sterilized warm water in which one-third per cent. of salicylic acid has been dissolved. The end of the glass tube or rubber tubing of the fountain syringe should be held in different parts of the abdominal cavity, especially in the deepest portion of the pelvis and the lumbar regions so as to direct the current of the antiseptic solution out of and not into the peritoneal cavity. After the abdominal cavity has been cleansed by flushing it is dried by sponges wrung out of a 1-5000 solution of sublimate. In such cases drainage should never be omitted. The closure of the external incision when intra-abdominal pressure is ex-

cessive is greatly facilitated by covering the intestines with a napkin or thin compress of gauze which is tucked underneath the margins of the wound all around. The sutures should be all introduced before any of them are tied. When the sutures are all in place they are tied from above downwards. If tension is considerable it is necessary to add two or more button sutures, which are only passed down to, but not through, the peritoneum, and are removed as soon as the tympanites disappear.

VII. *After Treatment.*

Uniform equable support of the abdomen by strapping and bandages over the antiseptic absorbent dressing furnishes efficient support to the distended abdominal walls and the paretic intestines, and is not only grateful to the patient but is an important aid in relieving the distress due to distension and peristalsis. I have insisted that in all operations for intestinal obstruction efforts should be made to empty the bowel not only at the seat of obstruction, but as far as it can be done, as such immediate evacuation constitutes one of the elements of success.

J. Greig Smith states distinctly that "No case of operation for intestinal obstruction is properly concluded until the distended bowels are relieved of their contents." One of the most favorable symptoms after a successful operation for intestinal obstruction is a spontaneous action of the bowels, as it not only proves the permeability of the intestinal canal, but is also an evidence that peristaltic action has been restored. The retention of fæcal material in the distended paretic intestines after operation for intestinal obstruction is a condition which not only retards recovery, but is in itself a grave source of danger. Through the sympathetic nerves the distended intestine exerts a most depressing effect on the cerebro-spinal centres, while the putrefactive changes which are constantly going on in the stagnant intestinal contents must be a constant source of intoxication, and at the same time the migration of septic micro-organisms through the paretic walls threaten life from septic peritonitis.

Mr. Tait has taught us the value of cathartics in the prevention of peritonitis after abdominal operations. Would it not be rational to follow his example in the after-treatment of operations for intestinal obstruction? I have repeatedly made the observation that the paretic intestine above the seat of obstruction will respond slowly, but surely to mechanical irritation, and it is only logical to conclude that the same effect would be produced by the administration of a brisk saline cathartic. *Dangerous as the use of cathartics necessarily must be before the obstruction is removed, so beneficial may their judicious employment be after the continuity of the intestinal canal has been restored by operative treatment.*

IV. Anatomico-Pathological Forms of Obstruction.

1. *Entero-lithiasis.*

a. Biliary calculi.—The term intestinal obstruction in the strict sense of the word is applied most appropriately to that form of obstruction where the lumen of the bowel is occupied and completely closed by a foreign body or an enterolith. A foreign body introduced into a healthy bowel, even if it completely fills its lumen, does not necessarily produce intestinal obstruction, as the healthy intestine is capable of dilatation to a sufficient extent to furnish an outlet to fluid intestinal contents between the wall of the bowel and the foreign body. The following experiments were made for the purpose of studying the effect of the presence of a foreign body of sufficient size to interfere with the passage of intestinal contents, and also with a view of ascertaining if the exclusion of peristaltic action of a certain segment of the intestine could produce intestinal obstruction. The operations were performed under strict antiseptic precautions, and the abdominal incision was always made through the linea alba. The animals were fed on the coarsest kind of food, and as a rule their appetites were not impaired by the operation.

Experiment No. 1.—Dog, weight 34 lbs. The ileum was drawn forward into the abdominal wound, and an incision made about an inch in length on the convex surface about twelve inches above the ileo-cæcal valve, and through this opening a stiff rubber tube four inches in length, and three-quarters of an inch in diameter, was inserted in a downward direction. The rubber tube distended the bowel so thoroughly as to produce a limited longitudinal rupture of the peritoneal coat. The tube was pushed forward as far as the ileo-cæcal valve, when the intestinal wound and the peritoneal rent were sutured. The visceral wound was covered with an omental graft which was of sufficient length to embrace the entire circumference of the intestine, and was fixed in its place by two catgut sutures, which were passed through the mesentery and both ends of the graft. The intestine was now thoroughly cleansed, dried, and returned, and the abdominal wound closed. The tube was passed per rectum in sixty hours. No symptoms of obstruction were observed during this time, and the animal remained in perfect health until killed twenty days after the operation. The intestinal wound was recognizable upon the external surface of the bowel by a ridge, which consisted plainly of a portion of the omental flap, the remaining portion had evidently disappeared by

bsorption, at least it had become invisible to the naked eye. The nterior surface of the bowel along which the rubber tube had to pass on its way out of the body presented nothing abnormal.

Experiment No. 2.—Dog, weight 24 lbs. In this instance the incision in the bowel was made eighteen inches above the ileo-cæcal region, and instead of a rubber tube a glass tube three and three-quarters of an inch in length, and half an inch in diameter, was introduced, and pushed along the bowel until its distal end was within six inches of the ileo-cæcal valve. Omental graft over the visceral wound. No symptoms. Tube passed in sixty-eight hours. Dog killed fifty-seven days after operation. Intestinal canal throughout healthy. Omental graft had disappeared completely.

Experiment No. 3.—Dog, weight 62 lbs. Incision of bowel twelve inches above ileo-caecal region, and of sufficient size to permit the insertion of a glass tube five-eighths of an inch in diameter, and six inches in length, which was pushed in a downward direction to within an inch of the ileo-cæcal valve. The tube filled the lumen of the gut completely, but produced no tension in the walls. No symptoms. One month later the abdomen was again opened, and the tube was found in the descending colon. The abdomen was closed, and the tube was passed per rectum four days later.

In these experiments hollow tubes were used, and it might be claimed that intestinal obstruction was not produced because the fluid intestinal contents could pass through the lumen of the tube. The effect of the peristaltic action of the bowel in that portion occupied by the tube was certainly eliminated as far as the fæcal circulation is concerned, and yet no symptoms of obstruction during life were observed, and the post-mortem appearances indicated that no obstruction had existed during life. It is certainly surprising that the peristaltic action of the intestine should be able to force a rigid tube of such length and dimensions as were used in the last two experiments through the ileo-cæcal valve into the colon.

In the following experiments the foreign body which was introduced was of such a structure that in case it filled the entire lumen of the bowel it would of necessity produce intestinal obstruction, unless a space for the passage of intestinal contents would be created between the foreign body and the intestinal wall by dilatation of the bowel.

Experiment No. 4.—Dog, weight 34 lbs. Intestine was incised at the junction of the ileum with the jejunum and the barrel of a glass female syringe six inches in length and half an inch in diameter was inserted with the closed end in a downward direction. The animal never showed any untoward symptoms, and as the syringe was not

found in the fæcal discharges the animal was killed six weeks later, when it was ascertained that it must have passed at some previous time through the normal outlet, as it could not be found, and the intestine presented throughout a normal appearance.

Experiment No. 5.—Dog, weight 60 lbs. In this experiment the incision in the bowel was made thirty inches above the ileo-cæcal valve, and through it was inserted with considerable force a glass female syringe 6½ inches long and three-quarters of an inch in diameter with a metal cap, which considerably increased its diameter at this point. The piston of the syringe projected one inch and a half from the cap. The perforated end of the syringe was directed downwards. Visceral wound protected with a circular omental graft. For the first few weeks the animal appeared to be in a good condition, and the fæcal discharges were normal. Later the apetite became impaired and the last few days obstinate constipation appeared. The dog was killed forty days after the insertion of the foreign body. At this time the syringe could be plainly felt through the abdominal wall. The syringe was found in the ascending colon, having passed through the ileo-cæcal valve. The ileo-cæcal region was distended, and the bowel at this point partially obstructed by a mass of straw, hair, fragments of bone, etc., for a distance of about ten inches. Above this point the bowel was considerably dilated and contained liquid fæcal matter. Several ulcerations were found in the portion of ileum traversed by the syringe. The lowest ulcer was about an inch and a half in length, and half an inch wide, reaching as far as the ileo-cæcal valve and apparently of recent date. The next ulcer, about one inch longer, but of the same width, was found six inches higher up. This ulcer presented a granulating surface and beginning cicatrization. The third point of ulceration was twelve inches above the ileo-cæcal valve, in an advanced stage of cicatrization. These ulcers were evidently of a traumatic origin and were undoubtedly caused by friction of the intestinal wall against the projecting point of the piston in the attempts of the bowel to propel the foreign body by increased peristaltic action. In this case the intestinal obstruction commenced with the accumulation of solid material on the proximal side of the syringe, being in reality not caused by the foreign body, but by the coprostasis. Had this latter condition not developed the foreign body would undoubtedly have been expelled spontaneously as in the former experiments. These experiments furnish positive proof that a foreign body of sufficient size to fill the entire lumen of a healthy intestine above the ileo-cæcal valve causes no obstruction, and that when obstruction takes place in such instances it is caused by tissue changes in the intestinal wall arising from pro-

longed contact with the foreign body. In reference to these points we shall consider the subject of entero-lithiasis as a cause of intestinal obstruction. Entero-lithiasis in man is due in the great majority of cases to the impaction of a gall-stone or the formation of an entero-lith in the lumen of the bowel the nucleus of which is a gall-stone. It has been a disputed question in what way a gall-stone of sufficient size to give rise to obstruction could enter the intestinal canal. Rokitansky asserted that a calculus the size of a hen's egg may pass through the bile-ducts. It is now generally believed that, as a rule, at least, such large concretions can only escape from the gall-bladder by ulceration through its walls, or that a gall-stone of smaller size after it has passed through the bile-ducts subsequently becomes larger by the formation of concentric concretions during its retention in the intestinal canal. In reference to the frequency of this form of obstruction Leichtenstern has found that in 1541 cases of intestinal obstruction with different causes tabulated by himself, in 41 it was produced by gall-stones.

Wising* collected fifty-one cases of intestinal obstruction caused by the presence of a biliary calculus, with the result that in only 24 of them could the anatomical condition of the gall-bladder be ascertained. In 18 of these the post-mortem appearances showed that the calculus had entered the intestine from the gall-bladder by a process of ulceration, and only in three cases it appeared as though the calculus had passed through the common bile-duct. In 33 cases the place of obstruction was 12 times the jejunum, and 21 times the ileum. In the 21 cases where the calculus was impacted in the ileum the seat of obstruction in two was in the middle, in 6 in the upper half, and in 12 in the lower half of this portion of intestine. Icterus was observed only in 8 of the 51 cases. The prognosis is always very grave, as of the 51 cases 38 died. In 25 fatal cases, death occurred 14 times between the sixth and the eighth day, while in isolated cases it did not occur until from the ninth to the twenty-eighth day, and one patient died after two months from perforative peritonitis. Taking all cases of obstruction from gall-stones together, we can say that the seat of obstruction is located in the lower portion of the ileum in 50 per cent. of the cases. The upper part of the jejunum is the next most frequent site of obstruction, and in a few the gall-stone becomes impacted in the duodenum at the site where it has ulcerated through the walls of the gall-bladder and intestine. In 32 cases collected by Leichtenstern, the gall-stone occupied the duodenum and jejunum in 10 cases, middle of ileum in 5 cases, lower part of ileum in 17 cases. Treves is of the

* Ueber Gallenstein ileus. Nord Med. Archiv., B. XVII, No. 18.

opinion that gall-stones causing intestinal obstruction ulcerate directly into the intestine. He had collected 48 cases of obstruction due to gall-stones. In the majority of cases direct evidence of ulceration between the gall-bladder and duodenum was to be obtained. The gall-bladder was entirely disorganized in a case in which the gall-stone was supposed to have traversed the biliary ducts. When impaction takes place high up in the intestinal tube tympanites may be entirely wanting and the symptoms point rather to the existence of pyloric stenosis than intestinal obstruction. The higher the location of the impaction the greater the probability that the calculus attained its size within the biliary passages, and that it entered the intestine by a process of ulceration. In some cases the communication between the gall-bladder and the duodenum remained at the time of death, showing that perforation had only recently taken place. Wising has reported such a case. The patient was a woman, 70 years of age, who had never suffered from biliary colic or jaundice. The attack of intestinal obstruction was acute, fæcal vomiting being an early symptom, slight icterus and little tympanites, death on the fifth day. At the necropsy a biliary calculus 7 ctm. in length and 10 ctm. in circumference was found firmly impacted in the ileum. The intestine on the proximal side was found greatly distended and of a color suggesting incipient gangrene, while the bowel below the obstruction was pale and contracted. Gall-bladder ulcerated and contracted by cicatricial tissue communicating with the duodenum by a perforation above the common bile-duct. A smaller communication was also found between the gall-bladder and the transverse colon. Shattock* mentions a case under the care of Dr. Bristowe, in which the remains of the gall-bladder, which was very small, communicated directly with the intestine.

In some cases the pathological conditions within and around the gall-badder show evidences which go to prove that perforation had taken place long before the development of the intestinal obstruction. In such cases the gall-stone must have occupied the intestinal canal for a variable period of time without having given rise to obstruction, the intestinal contents passing between it and the intestinal wall in the same manner as in the experiments detailed above. In some cases the gall-stone becomes encysted and symptoms of obstruction are not produced until the size of the stone has increased by the addition of concentric layers of concretion. Harley† reported a case where a gall-stone became encysted in the duodenum. Woodbury‡ reports a case

* British Medical Journal, March 19, 1887.

† Path. Soc. Transactions, London. Vol. viii.

‡ Amer. Jour. Med. Sciences, January, 1880.

that came under the observation of Dr. T. H. Andrews, of a woman 60 years of age, who was suddenly attacked with symptoms of acute intestinal obstruction without having previously suffered from any disorder of the biliary passages. She died on the seventh day. A concretion the size of an English walnut was found firmly impacted in the upper portion of the jejunum. Upon section the concretion was seen to consist of a brown, friable, cortical substance, enveloping a dense, white crystalline body as large as a cherry, which was evidently cholesterine. It appears that in this case a small gall-stone which had passed through the bile-ducts without producing symptoms, was in some way retained high up in the intestine, and served as a nucleus for the formation of an enterolith of sufficient size to give rise to intestinal obstruction.

Barlow* reports the case of a woman 57 years of age who had symptoms of gall-stones for a year. She suddenly developed an acute intestinal obstruction from which she died. About the center of the ileum there was found a biliary calculus of the size of a walnut partially sacculated. In some rare cases the obstruction is caused by the retention of numerous calculi in a circumscribed portion of the bowel. Metcalfe† presented to the New York Pathological Society a specimen taken from a man 54 years of age, where the duodenum was occupied by numerous gall-stones in such a way as to give rise to complete obstruction. A calculus may attain great size before it becomes impacted. Smith‡ observed a case of acute intestinal obstruction which proved fatal on the fifth day, where the post-mortem revealed the cause to be a biliary calculus measuring $4\frac{1}{2}$ by $2\frac{1}{2}$ inches in circumference, which was found impacted in the jejunum 30 inches below the pyloric orifice of the stomach. Clark§ relates the case of a woman 58 years of age who died of acute intestinal obstruction where two large gall-stones were found impacted immediately above the ileo-cæcal valve, each of which was one inch in length and four inches in circumference, and together weighed $1\frac{1}{4}$ ounces. The stones were composed of cholesterine and coloring material of bile. The intestine was perforated at the seat of impaction and a number of small gall-stones were found in the peritoneal cavity. The biliary passages were dilated and thickened, but the gall-bladder appeared to be normal in size and structure and not adherent to the duodenum; jaundice had never existed. Eight months previous to the last illness she had a

* Guy's Hospital Reports, 1884.

† Transactions New York Pathological Society, vol. ii., pp. 2, 3.

‡ Pathological Society's Transactions, London, 1854.

§ A case of large biliary concretion in the ileum. Medico-Chirurg. Trans., vol. lv., p. 1.

similar attack of obstruction and at that time a firm tumor could be felt in the right hypochondriac region. This and the next case illustrate that the great danger of impaction of a gall-stone consists of textural changes of the intestine at the site of impaction. Meymott's* patient was a woman 47 years old, who died after a short illness, during which symptoms of intestinal obstruction were well marked. At the necropsy a gall-stone composed of cholesterine, and weighing 400 grains was found impacted in the ileum four inches above the ileocæcal valve. At the seat of impaction circumscribed gangrene and perforation had taken place.

Fagge,† in his excellent paper "On Intestinal Obstruction," gives an account of a case which he examined, where in a woman 69 years of age who had died with symptoms of intestinal obstruction, a gall-stone measuring 4½ inches in its largest circumference and 2½ inches in its smallest, was found impacted in the jejunum 30 inches below the pyloric orifice of the stomach. The stone had passed from the gall-bladder into the duodenum through a perforation, firm adhesions having prevented its escape into the peritoneal cavity. In two other cases to which the same author refers the patients suffered from intestinal obstruction, and recovery followed after the evacuation of gall-stones of immense size. In cases terminating by spontaneous recovery he believes that perforation takes place into the colon. That the danger is not always passed when a large biliary calculus enters the colon directly through a perforation of the gall-bladder is well illustrated by a case reported by Bourdon,‡ where the calculus became lodged in the sigmoid flexure, where it produced an inflammation which proved fatal. In a number of cases recovery took place by discharge of the calculus per viam naturalis even after the symptoms had pointed to complete obstruction. The largest stone which has been successfully passed was 3½ inches in circumference. Pye-Smith§ narrates a case which would tend to show that in cases of intestinal obstruction due to the presence of a biliary calculus a spontaneous cure is possible even after the symptoms have continued for a number of days. The patient was a female 78 years of age who had never suffered from jaundice, and gave no history of biliary colic. She had always been very constipated; obstruction finally ensued; and after some temporary relief became complete. By external palpation no

* Impaction of a large Gall-stone in the Ileum. The Lancet, April 27, 1872.

† On Intestinal Obstruction. Guy's Hospital Reports, vol. xiv.

‡ Calcul biliare d'un volume considerable, tombé dans le tube digestif à travers les parois perforeé de la vesicule et du colon transverse. Gaz. des Hôpitaux, No. 72, 1859.

§ British Medical Journal, March 19, 1887.

tumor could be felt. On rectal examination, however, the finger could just reach a smooth, hard, moveable tumor, and it seemed probable that there was malignant disease of the colon. After thirteen days complete obstruction, however, the large gall-stone exhibited was passed, and the patient recovered quickly, and has subsequently remained free from the trouble.

Treatment.

Foreign bodies when impacted in the intestine set up inflammation, and this may go on to gangrene and perforation, and so it can be explained how cathartics under such circumstances are more likely to do harm than good. If impaction has taken place near the ileo-cæcal valve or in the colon, large injections and massage may be tried, provided symptoms of severe inflammation or gangrene at the site of impaction are absent. In the great majority of cases, however, the local lesions at the site of impaction are of such a nature at the time surgical aid is summoned that nothing short of a laparotomy will promise any hope of success. It will be well for the surgeon not to place too much importance upon the presence of tympanitic distension of the abdomen in these cases as an indication for the necessity of an abdominal section, as this sign may be entirely absent if the impaction is located high up in the intestinal tract, and if the impaction is in the lower part of the ileum or colon an operation should not be postponed until such distension has taken place. After the abdomen has been opened in the median line, and the seat of obstruction determined, the course to be pursued will depend upon the pathological conditions at the seat of impaction. As the mucous membrane in contact with the foreign body is always first to suffer in consequence of the impaction, puncture and incision should be avoided at this point. As the cases must be few where such a stone, even soon after impaction has taken place, can be pushed along the intestinal canal and through the ileo-cæcal valve into the colon, submural crushing of the stone should be practised where attempts at distant displacement have failed, and where the condition of the intestinal wall is such that no fear need be entertained that gangrene or perforation will take place. The stone should never be attacked at the seat of impaction, but should be pushed in an upward or downward direction, and then removed if possible by breaking it up by manual pressure, or, if this fail, the method suggested by Tait,* of passing in a needle obliquely through the intestinal wall and attacking the calculus in this manner may be tried. A stout steel needle, such as is used for electrolysis is best adapted for this

* The Lancet, December 10, 1887.

purpose. The needle should always be introduced obliquely through the intestinal wall an inch or two below the impaction in order to secure healthy tissue for the seat of puncture. After the stone has been crushed and the debris within the gut has been pushed into a healthy segment of bowel below, the puncture in the serous coat should be closed by drawing the peritoneum over it with a fine superficial suture for the purpose of guarding against leakage. When efforts at submural crushing or fracturing of the enterolith have failed and it is deemed necessary to excise it, it is also advisable to push the foreign body within the gut in an upward or downward direction sufficiently far to bring it to a perfectly healthy portion of the intestine, as the healing process of the visceral wound made for its extraction would proceed more satisfactorily here, than where the tunics of the intestine had undergone pathological changes in consequence of the impaction. If the stone cannot be displaced and the incision must be made through an inflamed intestinal wall, a graft of omentum should be placed around the intestine after suturing the visceral wound so as to cover the wound, and its ends fastened together by two sutures passed through the mesenteric attachment. Such a procedure will place the visceral wound in the very best condition for healing and will furnish an additional safeguard against subsequent perforation. If the intestine at the site of impaction shows evidences of gangrene, or, if perforation has already taken place no efforts should be made to extract the stone, as under such circumstances the surgeon is compelled to resect that portion of intestine in which the stone is imprisoned. As patients presenting such conditions are always more or less collapsed it becomes of the greatest importance to finish the operation as rapidly as possible, consequently after the resection has been made in the usual manner the continuity of the intestinal canal should be restored by an operative procedure which can be executed without unnecessary loss of time. As the bowel above the seat of obstruction is always found greatly dilated, circular enterorrhaphy for this reason alone would be a difficult if not an impracticable task, hence both ends of the intestine should be invaginated to the extent of an inch and the invagination maintained by three or four superficial stitches of the continued suture, and the continuity of the intestinal canal restored by making an incision an inch in length in each closed end of the bowel on the convex surface about two inches from the sutured extremity and lateral apposition of the wounds secured by decalcified perforated bone plates. This method should always be preferred to circular enterorrhaphy in uniting the bowel after resection under such circumstances as the extensive and secure coaptatio

of serous surfaces greatly enhances the chances of early union between the coaptated bowels, and at the same time establishes a communicating opening equally serviceable as after circular suturing.

b. Intestinal Concretions.—We have already seen that a small gallstone when retained for a sufficient length of time in the intestinal canal may become the nucleus for an intestinal concretion, which by the addition of concentric layers gradually increases in size until it fills the lumen of the bowel and after its impaction gives rise to intestinal obstruction. Enteroliths causing obstruction have been described in which a variety of foreign bodies have been found as nuclei.

Cloquet* divides the concretions found in the alimentary canal into two classes. The first includes enteroliths in man, and bezoars in animals, both being the result of calcareous deposits secreted by the parietes of the intestines. The second class comprises abnormal masses, such as solids (animal or vegetable hairs which have escaped the process of digestion, and agglomerate to form ægagropilæ) pulvurent substances and foreign bodies such as kernels of fruit, biliary calculi, and hardened fæces. He described an enterolith which formed around a pin as a nucleus by deposits of phosphate of lime and which had become arrested in the cæcum where it caused the death of the patient. In another case he found that the nucleus was composed of an ivory pessary which had perforated the bowel on one side and the bladder on the other, the perforation in the bowel was covered by a concretion of phosphate of lime, while the part in the bladder was encrusted with uric acid.

Aberle† reported a case where chronic intestinal obstruction was caused by the presence of 32 enteroliths, each of which was composed of a concretion in concentric layers around a cherry stone as a nucleus. The concretions had collected in the colon and were successfully removed by rectal injections and cathartics. A chemical examination of the concretion showed that it was composed of phosphate of lime and a considerable quantity of fat, animal glue, and traces of cholesterine.

Schoor‡ described an enterolith which for five years had given rise to pain, first in the ileo-cæcal region and later in the left inguinal region, and was finally discharged spontaneously. It measured 4½ inches in length and 2.9 inches in width and weighed 44.9 grammes. On making a section of it, it was found that the central portion or nu-

* Amer. Jour. Med. Sciences, January, 1856, p. 216.

† Ein Fall von Steinbildung im Darmkanale. Würt. Med. Corresp. blatt., No. 23, 1868.

‡ Canstatt's Jahresbericht, 1853, B. II., p. 64.

cleus was composed of a triangular piece of bone around which in concentric layers the concretion was arranged. A chemical examination of the concretion showed that it was largely composed of phosphate of ammonia and magnesia, the remaining part of it consisting in vegetable fibres, coloring material of bile, cholesterine, and chloride of sodium.

Virchow* made a careful chemical and microscopical examination of an enterolith which had caused symptoms of obstruction in a woman, but was finally expelled after another severe attack of colica stercoralis. The stone measured 5 ctm. in length and 8.5 ctm. in its greatest circumference. On making a section through its center it was seen to be composed of a plum-stone surrounded by a shell 2 ctm. in thickness, made up of concentric layers of crystalline bodies held together by a brownish mass. Chemical analysis showed that the shell was composed largely of phosphate of ammonia and magnesia.

In Friedländer's case† the obstruction was due to the impaction of an enterolith in the ileum 30 ctm. above the ileo-cæcal valve which was composed of shellac. The patient was a cabinet maker, and it is said that the apprentices of this trade not infrequently consume the alcoholic solution of shellac used for varnishing; in the stomach the alcohol is absorbed, and the shellac is deposited. In this case the stomach contained a large number of the same kind of concretions.

At the meeting of the Congress of German Surgeons in Berlin, in April, 1880, Langenbuch‡ showed some large concretions, some of which he had removed by enterotomy in a patient who had suffer[illegible] from repeated attacks of intestinal obstruction. As the sympto[illegible] became more urgent and failed to yield to simpler measures, abdo[illegible]nal section was performed in the median line, and the operator wi[illegible]out much difficulty found a swelling in the jejunum, laid open t[illegible] intestine, and removed the mass of concretions which completely fill[illegible] the lumen of the bowel. Vomiting continued and the patient died few hours after the operation. The necropsy revealed a second st[illegible] larger mass in the pyloric region of the stomach. Virchow examine[illegible] the concretions and found that they consisted almost exclusively organic substances, and especially of the derivative of the biliary aci[illegible] known as dyslysin.

The surgical treatment of intestinal concretions is the same as i[illegible] cases of impacted gall-stone.

c. Parasites as a cause of Intestinal Obstruction.—A few cases intestinal obstruction have been recorded where the obstruction wa[illegible]

* Virchow's Archiv., B. XX., Heft 3 u. 4.

† Schellack-steine als Ursache von Ileus. Berl. Klin. Wochenschrift, 1882, No. 1.

‡ Verh. der deutschen Gesellschaft f. Chirurgie, 1880.

caused by a mass of ascarides which interfered with the passage of intestinal contents in the same manner as an enterolith. Halma-Grund* refers to a patient ten years of age that came under his care suffering with the characteristic symptoms of acute intestinal obstruction, followed by hæmorrhage from the bowels, collapse and death. The necropsy revealed as the cause of obstruction a mass of ascarides, eighteen in number, which completely filled the lumen of the ileum. At the site of impaction an ulcer was found showing an eroded vessel which had been the source of hæmorrhage.

Saurel's† patient was 23 years of age, who suffered from symptoms which resembled closely an attack of intestinal obstruction. A swelling could be felt to the left of the umbilicus. Two ascarides were thrown up during a severe attack of vomiting. Anthelmintics were administered and injections given without any effect, and the patient died in collapse. The necropsy revealed the cause of obstruction to have been a mass of ascarides which were firmly impacted in the lower part of the ileum.

Pockels‡ was called to attend a patient who had suffered for some time from an intra-abdominal swelling the size of a hen's egg which could be distinctly felt below and to the left of the umbilicus. A purge of male fern and jalap expelled 103 ascarides, after which the tumor disappeared and the patient's health was completely restored.

Stepp§ has recently recorded an instance in a boy, aged 4, who died with symptoms of acute intestinal obstruction an hour and a half after medical aid was summoned. The post-mortem showed that the intestine was completely obstructed by a twisted mass of some forty or fifty round worms, lodged just above the ileo-cæcal valve. The ileum contained some thirty-five more higher up, and there were a few in the stomach and œsophagus. The mother of the child had given the patient some worm medicine a few days before the acute attack and Stepp thinks that the worms, weakened by the medicine, were dislodged in numbers by the violent peristalsis set up by an injudicious diet afterwards, and so rolled down in a tangled mass too large to pass the ileo-cæcal valve.

When the surgeon is called upon to treat a case of intestinal obstruction in a child, such a cause should be borne in mind, as in a case of this kind a timely anthelmintic remedy followed by a brisk cathar-

*Enteritis Verminosa mit Darmblutung u. Einklemmungserscheinungen. Schmidt's Jahrbücher, B. 99, p. 92.

† Darmverstopfung durch Würmer. Schmidt's Jahrbücher, B. 99, p. 92.

‡ Briefliche Nachrichten über Rundwürmer. Schmidt's Jahrbücher, B. 99, p. 92.

§ Centralblatt f. die med. Wissensch. 1888, No. 27.

tic may prove efficient in removing the cause of obstruction. If such treatment should prove unavailing, no time should be lost in resorting to operative treatment by abdominal section, which is to be conducted in the same manner as in operations for intestinal concretions.

d. Fæcal Obstruction.—Fæcal obstruction is almost without exception met with only in the large intestines and here in preference in the cæcal region or in the sigmoid flexure. Cases have been reported where a congenital abnormal dilatation of some part of the colon predisposed to this affection. The acquired form of dilation which attends all cases is the result of prolonged over-distension resulting in paresis of the distended segment of the bowel.

Boys de Loury * has collected a number of cases of retention of fæces in the cœcum and colon which finally gave rise to inflammation at the seat of impaction and intestinal obstruction. Among them was one observed by Nélaton where the fæcal tumor occupying the cæcum and ascending colon by pressure against the under surface of the liver and gall-bladder caused icterus. The icterus and symptoms of obstruction disappeared promptly after the removal of the fæcal accumulation by cathartics. Retention of fæces after a time produces more or less acute enteritis, attended by tympanites, pain, and dyspnœa. The patients usually have been constipated for a long time, sometimes alternated by diarrhœa. The retained fæces become inspissated and hard and form mural concretions, the middle often remaining tunneled for the passage of fluid fæces. The masses are modelled and when thrown off, often describe in accurate outline the contour of the bowel. Distension of the bowel often takes place to an enormous extent. Cruveilhier found on making a necropsy on an old man the transverse colon dilated so that it measured 35 ctm. in circumference. The cæcum was even more dilated and was the size of a child's head. In one of my cases of periodical accumulation of fæces in the sigmoid flexure the patient would only return for treatment at a time when symptoms of obstruction set in and every time he presented himself the swelling would occupy almost the entire space in the abdomen below the umbilicus. Mechanical removal of the fæcal accumulation followed by massage and the use of the Faradic current and galvanism had no effect in diminishing the size of the bowel, or in preventing the periodical accumulation of fæces. If the cæcum alone is the seat of impaction it often presents the appearance of a circumscribed tumor which may and has been mistaken for an ovarian tumor, abscess or carcinoma. The retained mass constitutes an irritant which sooner or later causes a catarrhal

* Gaz. hebd., 1858, No. 28.

enteritis, which extends to the remaining tunics and is often the direct cause of perforation or diffuse peritonitis. In some instances the inflammation extends to the connective tissue around the intestine and an abscess forms without an antecedent perforation. The distended bowel gradually becomes paretic and the local and general symptoms are aggravated.

One of the most important diagnostic points is to make pressure over the tumor in chloroform narcosis when the fæcal masses become displaced, leaving a permanent depression at the point of pressure. If the impaction is within reach the removal should be accomplished by the use of a scoop assisted by copious injections. If the bowel at the seat of impaction has lost its contractility the use of cathartics is useless, and if it is in a state of inflammation positively hurtful. In such cases massage and high injections are indicated. Perforation and suppurative inflammation in the connective tissue surrounding the bowel must be met by prompt surgical treatment. In cases where all ordinary measures fail in removing the fæcal accumulation and the symptoms of obstruction continue unabated, it would be not only justifiable, but good surgery to cut down upon the distended bowel and to break up the mass within the gut and push it along to a portion of the intestine where peristaltic action has not been impaired. In cases where the intestinal wall presents pathological conditions which would contra-indicate such a course of treatment, it may become necessary to resort to enterotomy and remove the fæcal mass through the wound and according to circumstances either close the visceral wound by suturing or establish a temporary artificial anus in one of the inguinal regions.

2. *Invagination.*

Treves * asserts that thirty per cent. of all forms of intestinal obstruction, exclusive of hernia and congential malformations, are cases of invagination. The same author recognizes clinically four forms. The ultra acute is very rare, and terminates fatally in twenty-four hours ; the acute, lasting from two to seven days, numbered about forty-eight per cent. of all cases of invagination ; the subacute, lasting from seven to thirty days, are about thirty four per cent.; and the chronic, lasting over thirty days, occurred about eighteen times out of every one hundred cases. As far as the operative treatment is concerned it is exceedingly important to classify all cases into acute and chronic, as in the former class the symptoms appear with great violence and the pathological changes at the seat of invagination come

* The Lancet, December 13, 1884.

on so rapidly that death is inevitable unless efficient surgical treatment is resorted to before the tissues at the seat of invagination have undergone changes incapable of repair. In the chronic form the symptoms are never so urgent and the adoption of early radical measures is not as urgently indicated. Of the anatomical forms, the cases collected by Treves thirty per cent. were enteric ; eighteen per cent. were colic ; forty-four ileo-cæcal, and eight were ileo-colic. The enteric forms are most common at the lower part of the jejunum, and are small. The colic forms are mostly to the left of the transverse colon. The latter as a rule belong to the chronic form of invagination.

Leichtenstern * calls an invagination ileo-cæcal when the ileo-cæcal valve is pushed forward and forms the apex of the intussusceptum and ileo-colonic when the ileum is pushed through the valve. The invagination always increases at the expense of the intussuscipiens. In examining four hundred and seventy-nine cases of invagination in reference to the anatomical location of the lesion he gives the following figures:

Ileo-cæcal	212
Ileum	142
Colon	86
Ileo-colonic	39
	479

I shall not endeavor to elaborate upon the views entertained by different authors and experimenters concerning the mechanism of the ordinary forms of invagination, but from a surgical aspect it is important to allude to some of the pathological conditions which produce the invagination, and at the same time complicate the treatment. Mr. Bellamy† has described the case of a very rare form of intestinal obstruction due to invagination of a portion of the small intestine in the walls of the rectum successfully treated by abdominal section. The obstruction had been complete for nine days. The patient was a female who had been subject to obstinate constipation, and on three occasions the retention of fæcal matter had given rise to serious symptoms which, however, had always yielded to ordinary means. On admission into the hospital, a hard swelling could be felt in the left iliac fossa, in the region of the inguinal canal and sigmoid flexure. Manual examination of the rectum disclosed an obstruction in the upper part of this portion of the intestine. As the symptoms of ob-

* Uber Darm-Invagination. Prager Vierteljahrsschrift f. Heilkunde. B. II. u. III. 1873

† British Medical Journal, March 8, 1879.

struction became urgent and failed to yield to ordinary treatment abdominal section was performed after exploration of the left external inguinal ring which had been the seat of an old hernia, by enlarging the incision upwards and obliquely outwards. On introducing the hand into the abdomen it was ascertained that the swelling in the iliac region was composed of a knuckle of small intestines which was obviously invaginated in the anterior aspect of the first part of the rectum, and in addition there was felt what appeared to the touch to be bands of organized lymph, stretching across in the same place, and probably the result of a former circumscribed peritonitis. The operator introduced his right hand into the rectum and pushed the prolapsed mass upwards and towards his left hand, which was in the pelvic cavity, at the same time breaking down the adhesions and gently drawing out the knuckle from its imprisoned position, and freeing it from the peritoneal fold. The symptoms of obstruction subsided promptly and the patient after having passed through a moderate attack of peritonitis made a complete recovery.

In examining the literature of the subject the author had been unable to find any case where abdominal section had been performed for a similar condition, although Lockhart described this form of hernia, but he stated that he had never known an operation necessary. The cause of a chronic invagination is often a tumor attached to the inner surface of the bowel. The tumor by its weight drags the portion of intestine to which it is attached into the segment of bowel below and the descent of the intussusceptum is often very slow. In these cases the tumor is always found attached to the apex of the intussusceptum. Invagination caused by tumors is most frequent in the large intestines, as these are more frequently the seat of tumors than the intestinal canal above the ileo-cæcal valve. Tuffier* reports a case of invagination operated on by Marchand which is of special interest on account of the rare condition found which had led to the invagination.

The patient was a woman 43 years of age, who had suffered from a gradually increasing intestinal obstruction. Rectal examination revealed a tumor which had dragged an upper segment of the bowel with it into the rectum. Marchand opened the abdomen in the left inguinal region and found an invagination of the sigmoid flexure into the rectum. Reduction was found impossible. An artificial anus was established after the method of Littré. Death on the fifth day. The necropsy showed diffuse peritonitis which in the small pelvis had

* Invagination de S'illiaque dans le rectum. Laparotomie laterale. Anus de Littré. Lipome de intestin. Le Progreès Mèdicale, 1882, p. 202.

assumed a suppurative type. The sigmoid flexure was found invaginated to the depth of 6 ctm., the serous surfaces adherent, which only gave way to considerable traction force. A pedunculated lipoma was attached to the apex of the intussusceptum.

Kulenkampff* reports a case of a woman, aged thirty-nine years, who had suffered from incomplete obstruction of the bowels with bloody discharge from the anus for six months. During the progress of the disease a mass could be felt in the rectum, which was thought to be a polypus. This proved to be a papilloma (probably malignant) that originated in the sigmoid flexure, and had been the cause of the invagination of that part of the colon into the rectum. The entire mass, including the intussusceptum was removed through the rectum. An adherent coil of intestine was accidentally wounded and the wound was at once closed by suturing. The operation was followed by an aggravation of the symptoms of obstruction, on the tenth day laparotomy had to be performed, and an artificial anus was established in the left groin. The patient recovered, but the fæcal fistula remained.

Bryant† related the case of a lady, aged seventy-four, who had been suffering from obstruction due to invagination for fourteen days. He suspected the existence of a growth, and this, after much difficulty, was found, drawn down, and removed, the patient making a rapid and perfect recovery.

Barker,‡ in a case of invagination of the rectum, due to adenoid epithelioma of that part of the gut, succeeded in drawing down and excising the affected part and reduced the invagination. The patient recovered completely. Three similar cases had been treated previously in the same manner, two by Verneuil, and one by Kulenkampff, only one of them recovering.

The case reported by Nicolaysen§ is of special interest as illustrating the course to be pursued when it becomes necessary to resect a portion of the intestine with the tumor. The patient was a woman forty-nine years old who had suffered from troublesome constipation and painful defecation for a year, due to chronic invagination of the sigmoid flexure of the colon into the rectum produced by an epithelioma. Through the rectum a tumor could be felt which by traction could be drawn down to the anus. The diagnosis made was a carcinoma of the colon and invagination of colon into rectum. The patient could produce the invagination at will. The extirpation was made by

* Centralblatt f. Chirurgie, 1886, No. 47.

† British Medical Journal, April 9, 1887.

‡ The Lancet, May 14, 1887.

§ Tumor carcinomatosus intestini S. romani: Resektion af S. romanum; Heltredelse. Nord. Med. Arkiv., B. XIV., No. 13.

pulling the tumor downwards beyond the anal orifice. The healthy mucous surfaces 2½ ctm. above the base of the tumor were circumscribed by a row of silk sutures which were carried through the entire thickness of both intestinal walls. The tumor was excised 1 ctm. below the sutures, only one artery had to be tied. Posteriorly and on the left side of the circular wound the divided meso-colon could be seen. The wound was accurately united by a superficial continued suture. As soon as the bowel was replaced it retracted as far as the upper portion of the rectum. The patient had recovered after fifteen days and reported herself well at the end of 2½ months. The intestinal tube removed measured 6.5 ctm. The tumor under the microscope showed the typical structure of cylindrical-celled epithelioma.

Becker* has collected a number of cases from literature where the cause of the invagination was a diverticulum of the small intestine, and he believes that in some of the reported cases of elimination of portions of the intestine with the appendix vermiformis were of this kind, that in these cases what appeared as the appendix was in reality a diverticulum.

The mechanical disturbances at the seat of invagination sometimes are the cause of an additional obstruction. In one of Dent's cases in a child six months old, who for three days before admission into St. George's Hopital had suffered from evident intussusception the abdominal section revealed a two-fold cause for the obstruction, invagination and internal strangulation. When the abdomen was opened a loop of bowel was found constricted by the sharp edge of a piece of mesentery of the ileum which was invaginated into the cæcum. The band was divided and the invagination easily reduced. Peritonitis had set in before the operation, and the child died in five hours after it. This case should remind us to look for additional causes of obstruction around the site of the invagination in all cases where the abdomen is opened in the treatment of intussusception. Similar care should be exercised under the same circumstances after the reduction has been accomplished to look for an additional invagination, as cases have been reported where two or more invaginations were present at the same time.

Claudot† has given an accurate description of a specimen of double invagination in a patient who had died with symptoms of intestinal obstruction. The first invagination was 80 ctm. below the pylorus, the second two metres further down, the latter consisted of an invagination of the ileum into the colon, the intussusceptum having ad-

* Zur Aetiologie der Darmeinschiebung. Dissertation. Kiel, 1885.

† De l'occlusion intestinale. Thèse, Paris, 1884.

vanced nearly the entire length of the ascending colon. The upper invagination showed evidence of gangrene, of which no sign could be seen in the lower, and for this reason it is probable that the upper invagination occurred first. Intestinal hæmorrhage was one of the prominent symptoms during life in this case.

At a meeting of the Pathological Society of London, Power* demonstrated a specimen obtained from a child five months old of double intussusception, one in the ileo-cæcal region two inches in length, the other in the transverse colon, one inch in length. The latter was an ascending invagination. Both invaginations showed adhesions between the serous surfaces, and consequently must have been ante-mortem conditions.

In regard to the age of patients suffering from invagination, it can be said that fifty per cent. of all cases occurred in persons under ten years of age. According to Heusner in children invagination is the cause of obstruction in three-fourths of all cases of intestinal obstruction. If all cases of invagination were tabulated it would be seen that one-fourth of the whole number would be children under one year of age. The acute form is most frequent in the young, and the chronic variety between the ages of twenty and forty.

Leichtenstern† has studied the mortality which attends invagination, and in 557 cases in which the termination was known the result was as follows:

Age.	Total mortality.	Mortality of cases without elimination of gangrenous portion.
1 year	88	86
2 years	82	
2-10 "	72	80
11-20 "	63	86
21-40 "	63	82
41-50 "	63	80
51-60 "	71	
More than 60 years	77	

From this table it can be seen that the mortality up to the age of forty increases with the diminution of the age of the patients, being greatest in infants and children in whom the invagination usually pursues an acute course.

Pathology of acute Invagination.

The pathological changes in the acute form of invagination are chiefly of two kinds: 1. Obstruction of the bowel; 2. Strangulation of the intussusceptum. Both of these results may be absent in the

*Transactions, vol. xx., p. 240.

† Ueber Darminvagination, iii. Theil, Prager Vierteljahrsschrift f. Heilkunde, B. XXX., p. 17.

chronic form. The obstruction is not only due to the narrowing of the lumen of the bowel by the invagination, but also to the swelling of the invaginated portion caused by the constriction of the blood vessels supplying the intussusceptum at the neck of the intussuscipiens. In cases of chronic invagination where no such vascular engorgement is present the lumen of the intussusceptum remains sufficiently large for a free passage of the intestinal contents, and no symptoms of obstruction are observed. In a number of my experiments on animals where I produced invagination artificially no symptoms of obstruction were observed, and when the animals were killed weeks or months after the invagination had been made, the lumen of the intussusceptum was not larger than an ordinary lead pencil, and yet the bowel on the proximal side was not dilated, but somewhat hypertrophic. The greatest danger after invagination has taken place arises from the constriction of the intussusceptum at the neck of the intussuscipiens. The acuity of the symptoms are always proportionate to the severity of the strangulation at this point. The circular constriction interferes with the return of venous blood from the intussusceptum which is followed by œdema, complete stasis and gangrene of the constricted portion. An acute invagination becomes irreducible to ordinary means within a few hours on account of the appearance of œdema in the intussusceptum. If the strangulation is less intense the passive congestion precedes a plastic inflammation of the serous surfaces held in apposition and adhesions form which again oppose or render a reduction impossible. In cases where gangrene of the invaginated portion follows a few hours or days after the invagination no adhesions form between the serous surfaces. Adhesions at the neck of the intussuscipiens and throughout the extent of the invagination may form soon and they may be absent after six weeks in the chronic variety. Adhesions are met with in about 80 per cent. of chronic cases, and 40 per cent. of acute ones. In acute cases a fatal termination usually takes place from perforation at the neck of the intussuscipiens followed by septic peritonitis. Numerous cases have been reported where a spontaneous cure was effected by sloughing and elimination of the intussusceptum. This favorable termination is only possible if the continuity of the intestine is restored at the neck of the intussuscipiens by firm unyielding adhesions before the proximal end of the intussusceptum has become gangrenous, or if the line of demarcation is below the neck. Gangrene usually commences at the apex of the intussusceptum and travels in the direction of the neck. That sloughing and elimination of the intussusceptum are not always followed by recovery becomes evident from a study of 149

cases collected by Leichtenstern where this occurred. Out of this number 61 died and 88 recovered, a mortality of 41 per cent. Separation of the gangrenous intussusceptum usually takes place in acute cases from the eleventh to the twenty-first day, and in children somewhat earlier than in adults. The length of the slough corresponds with the length of the invaginated portion, and cases are on record where recovery followed after the elimination of five or six feet of intestine. According to Treves spontaneous elimination takes place in about 40 per cent. of all cases. The frequency with which it takes place in the different anatomical forms varies, being 20 per cent. in the ileo-cæcal form, 28 per cent. in the colic and 61 per cent. in the enteric form, so that it is most rare in the most common variety. The frequency of elimination of the gangrenous part increases with the age of the patient, being least common in infants on account of the rapidly fatal course of the disease in them, and most frequent in patients advanced in life.

Birch-Hirschfeld* gives an accurate post-mortem description of a child two years of age which had recovered from a double invagination by sloughing an elimination of the intussusceptum, and died four months later of measles. At the necropsy it was found that the lower portion of the ileum, the cæcum and appendix vermiformis were absent. A circular cicatrix in the lumen of the gut showed where separation had taken place ; upon the serous surface at the same point a circular depression indicated the site where separation had occurred. The second invagination had evidently been in the colon at the junction of the ascending with the transverse portion, as a similar cicatrix was also found in this locality. The cures after spontaneous elimination of the intussusceptum are often more apparent than real as such an ideal restoration of the intestinal canal as described by Birch-Hirschfeld is but rarely effected.

Kuettner† has followed up the history of several of these cases and has found that not an inconsiderable number of them die later of perforation and peritonitis. Stricture of the intestine has also been observed as a sequela in some of these cases.

Gerry‡ reports such a case. The invagination was acute and after three weeks a portion of the small intestine, 17½ inches in length, passed per anum followed later by a number of smaller fragments. Soon after the apparent recovery had taken place, symptoms of ob-

* Fälle von Geheilten Invaginationen des Darmes. Archiv der Heilkunde, 1869, Heft 1, p. 108.

† Drei Fälle von Intussusception und deren præsumptive Heilung. Virchow's Archiv., B. LIII., p. 274.

‡ A case of Intussusception. Boston Medical Journal, 1877, No. 25.

struction again set in, due to the formation of a stricture at the point where spontaneous resection had taken place from the effects of which the patient died seven months after the invagination. At the necropsy a circular stricture was found in the upper part of the small intestine, with loss of several feet of the intestine by sloughing, a fistulous communication between the small intestine and the descending colon and chronic peritonitis.

Pathology of Chronic Invagination.

In cases of chronic invagination the symptoms are identical with those of intestinal stenosis from other causes. The constriction at the neck of the intussuscipiens is not sufficient in degree to arrest the circulation in the invaginated portion, consequently gangrene does not take place. The seat of the invagination and the bowel on the proximal side become the seat of hyperplastic changes from the chronic congestion which attends the lesion and from the increased peristalsis which is maintained by the chronic obstruction.

Pohl* has described an interesting specimen of chronic invagination taken from a man 62 years of age who suffered from two attacks of intestinal obstruction eleven years apart. The second attack proved fatal after an illness of eleven days. The post-mortem appearances indicated that invagination which was found had existed for eleven years, and that the second attack was due to an aggravation of the mechanical difficulties at the seat of invagination, and which had given rise to ulcerative inflammation of the mucous membrane lining the intussusceptum, perforation and suppurative peritonitis. The intussusception was located in the lower portion of the ileum. The intussuscipiens was 30 ctm. in length, its muscular coat hypertrophic, mucous membrane thickened and very vascular, and some of its folds adherent to the enclosed intestine; on the posterior wall near the mesenteric attachment two perforations were found. The intussusceptum was 24 ctm. in length and its mucous membrane extensively ulcerated, old and firm adhesions at the neck of the intussuscipiens. The mesentery of the ileum throughout, but especially at the seat of invagination, much thickened. Ileum above obstruction dilated and its walls thickened.

Leichtenstern† reports a case of chronic invagination which presents a number of interesting points. The attack was brought on by indiscreet diet and was attended by well marked symptoms, tenesmus,

*Ueber den Befund einer durch viele Jahre getragene Darm-Intussusception. Prager Med. Wochenschrift, 1884, No. 21.

†Darm-Invagination von monatlicher Dauer. Deutsches Archiv. f. Klin. Medicin, B. XII., p. 381.

liquid stools mixed with mucus and blood. The patient lived for eleven weeks. After the first few days the stools were normal in size and consistence. Recurring colicky pains, often very severe, constituted the most troublesome and important symptom. A swelling in the region of the transverse colon could always be felt, but became firmer and more circumscribed during the attacks of colic or after a prolonged examination by palpation. The necropsy revealed an ileo-cæcal invagination, the lowest portion of which consisted of the point of entrance of the ileum into the colon, the inner cylinder of the cæcum and ascending colon, and the outer cylinder or sheath of the transverse colon. All of the parts involved in the invagination were the seat of hypertrophic changes.

Treatment.

Early recognition of the existence of invagination is of the greatest importance for successful treatment, as the prospects for successful reduction by ordinary surgical means diminish with the development of secondary pathological conditions at the seat of invagination. Many of the artificial invaginations which I made in animals were reduced spontaneously within a few hours, and in order to study the effects of invagination I had finally to resort to suturing at the neck of the intussuscipiens in order to permanently retain the invaginated portion. Reduction was resisted after a time either by the swollen, œdematous intussusceptum or by the adhesions at the neck of the intussuscipiens, or between the serous surfaces throughout the invaginated portion of the bowel. From these observations I have come to the conclusion that reduction by gentle but efficient distension of the bowel below the invagination would succeed in the majority of cases if this procedure were practised before either of the two principal conditions which cause irreducibility have had time to make their appearance. As soon as the existence of an invagination is suspected the large intestines should be emptied of their contents by the administration of a large enema, the patient being kept in Hegar's position. After this has been done the patient should be placed thoroughly under the influence of an anæsthetic so as to facilitate the next step in the treatment by

Rectal Insufflation of Hydrogen Gas.

As gas can be readily forced beyond the ileo-cæcal valve this method of treatment is applicable in the treatment of invagination in any portion of the intestinal canal, and as distension of the intestine below the seat of obstruction may prove successful in correcting the mechan-

ical difficulties due to other causes it should be resorted to both as a diagnostic and therapeutic measure in the beginning of all cases of intestinal obstruction if a correct diagnosis cannot be made without it. The modus operandi of this surgical resource I witnessed in an animal on the third day after the invagination had been made by opening the abdomen and exposing to sight the seat of invagination before the insufflation was made. In this instance two inches of the ileum were invaginated into the colon and fixed by two fine silk sutures at the neck of the intussuscipiens. On the third day the abdominal cavity was reopened by an incision along the outer border of the right rectus muscle, and the invaginated bowel drawn forward into the wound. The bowel at point of operation was very vascular, and the neck of the intussuscipiens covered with plastic exudation. The sutures were removed and the rectum and colon distended with gas for the purpose of effecting reduction. As soon as the colon had become thoroughly distended the adhesions which had formed gave way with an audible noise, and complete reduction followed in such a manner that the part last invaginated was first released. As the force necessary to rupture the adhesions and to reduce the bowel produced no injury of any kind to the intestine below or at the seat of invagination, this experiment would tend to prove that insufflation can be practised successfully in cases of invagination of several days duration. The rectal insufflation of hydrogen gas in the reduction of an invagination should always be made under the influence of an anæsthetic administered to the extent of complete muscular relaxation. The pressure upon the rubber balloon should be uninterrupted and should never exceed two pounds to the square inch. Disinvagination is effected by inflation by two distinct forces. In the first place, the steady elastic pressure of the gas distends the bowel between the sheath and the returning cylinder which makes traction upon the neck of the intussuscipiens, while the column of gas by its pressure against the apex of the intussusceptum acts as a direct reduction force. In order to accomplish the desired mechanical effect the inflation must be made slowly and continuously, as when this is done there is less danger of rupturing the bowel than when rapid inflation is made under the same pressure, but with interruptions, and the object of the inflation is more surely realized. The return of the gas is prevented most effectually by an assistant pressing the margins of the anus against the rectal tube. A small gutta percha female syringe makes the best rectal tube. A sudden diminution of pressure indicates either that disinvagination has been effected or that a rupture of the intestine has occurred. It is exceedingly important that the surgeon should satisfy himself of the existence of a rupture if this

accident has occurred. The best way to recognize the accident is to continue the inflation under a pressure of not more than a quarter to half a pound to the square inch. If the invagination has been reduced the intestine above it will become gradually distended by the gas, and the distension of the abdomen takes place first over the middle of the abdomen and above the pubes, ascending gradually as the inflation is continued in an upward direction. If the intestine has been ruptured the gas escapes into the peritoneal cavity and the existence of the accident is proved by the appearance of a uniform free tympanites with disappearance of liver dullness. In a recent case there is no danger of rupturing the bowel under a pressure of two pounds to the square inch, and in cases where the tissue of the intestine yields under this pressure a laparotomy is the only proper remedy and the occurrence of the accident renders the indication for the performance of the operation imperative without adding to its danger.

Colotomy.

Two indications for colotomy might arise in the treatment of colic invagination: 1. In acute cases when the general symptoms are so grave as to contra-indicate a laparotomy. 2. In irreducible chronic cases, when the lower portion of the colon is invaginated into the upper part of the rectum where it is impossible to make a resection or anastomosis by lateral apposition. According to the location of the invagination the operation is made either in the right or the left iliac region, in the former instance the opening being made in the cæcum, and in the latter in the descending colon.

Dubois* reports a case of intussusception where the invaginated portion could be felt in the region of the sigmoid flexure through the abdominal wall. Colotomy was performed above the seat of obstruction and the patient not only recovered, but four months later the permeability of the intestinal canal was restored spontaneously but the artificial opening had not closed.

Enterotomy.

In irreducible iliac and ileo-cæcal invagination an enterotomy should only be made when the patient is in such a collapsed condition that more radical measures are inadmissible. As in the majority of cases the invagination is below the ileo-cæcal valve the artificial opening should be made in the right iliac region. Should the invagination be located higher up in the intestinal canal, and an empty collapsed

* Enterotomie pratiquée in extremis. Journ. de Méd. de Bruxelles, December, 1878.

coil of intestine present itself in the opening it should be pushed aside and search made for a distended loop. An enterotomy is justifiable even when the patient is in an almost pulseless condition, as this operation is attended by little, if any shock, as it can be done in a few minutes, and, if necessary, without an anæsthetic. Emptying the bowel above the seat of obstruction will bring relief by removing the abdominal distension and by favorably influencing the invaginated part by diminishing the hydrostatic pressure above the obstruction, which in itself is a potent cause in maintaining vascular engorgement.

Langenbeck * saved the life of a patient suffering from invagination of the colon by an enterotomy. The invagination had advanced so far that the apex of the intussusceptum could be felt in the rectum. He performed Nélaton's operation and the patient recovered. Nine months after the operation both the invagination and the artificial anus remained.

Laparotomy.

Remembering that the general mortality of invagination is 70 per cent. and in children less than eleven years of age spontaneous cure by elimination of intussusceptum does not exceed 12 per cent., it becomes plain that in cases where reduction is not accomplished by rectal inflation a laparotomy is indicated in all instances where the general condition of the patient is such as to justify such a procedure. It is true that the experience of the past in the operative treatment of invagination is not such as to inspire confidence, but it must not be forgotten that almost without exception the abdomen was only opened as a last resort after the patient had been completely prostrated by the disease or after the invagination had given rise to irreparable local conditions. Instead of discouraging operative interference the statistics collected so far furnish the best possible argument in favor of early operations where simpler measures have failed.

Ashurst † brought together, with more or less detail, the histories of thirteen cases in which laparotomy has been undertaken for the relief of intussusception. Of this number five recovered, and eight died. As the result of a study of his cases he has come to the conclusion that the operation is not admissible in patients less than one year of age, as all operations to that date done in children less than a year of age proved fatal. He also advises against an operation when the symptoms present, and particularly the existence of intestinal hem-

* Vorstellung eines Falles von geheilter Enterotomie. Verh. der deutschen Gesellschaft f. Chirurgie, 1878.

† Laparotomy for Intussusception. Amer. Journ. Med. Sciences, July, 1874, p. 48.

orrhage, render it probable that the tightness of the intussusception will lead to sloughing of the invaginated portion, as he claims that under these circumstances an operation would almost surely fail, while there is a fair hope that separation of the invaginated mass may lead to spontaneous recovery. Experience has shown that a cure by spontaneous elimination of the intussusception seldom if ever takes place in very young children and infants, consequently the hopelessness of the situation in such cases where legitimate efforts at reduction have failed can be advanced as the most logical reason in favor of operative treatment as the patient and surgeon have nothing to lose and everything to gain.

Knaggs * after reporting an unsuccessful case of abdominal section for invagination that occurred in his own practice gives the results of thirty-seven operations including his own. Of this number eight recovered, and twenty-nine died. In many of these cases peritonitis had set in before the operation was performed, and this condition and not the operation was answerable for the subsequent fatal issue.

Sands † has tabulated the records of twenty-one cases of laparotomy for intussusception, eight of which have occurred since the publication of Ashurst's paper. Of twenty cases in which the result of the operation is given, seven recovered, and thirteen proved fatal, thus showing a mortality of 65 per cent. After a study of these cases he came to the conclusion that the prognosis after operation is also influenced by the age of the patient; thus of twelve cases of two years old or under, three recovered, and nine died. Of seven cases sixteen years old or over, four recovered, and three died, showing that the mortality is greater in infants than adults. Sands remarks very properly that the mortality depends more on the condition of the intestine than the age of the patient. In taking all cases together he has found that the mortality of the operation is 14 per cent. in the easy, and 91 per cent. in the difficult cases.

The largest number of operations for invagination has been collected by Braun.‡ He tabulated fifty-one operations which were performed since 1870, that is, operations done under antiseptic precautions. Of this number, eleven patients were cured, and forty died. In twenty-seven of these cases disinvagination was effected, and in twenty-four it was not; of the former eighteen were children, and nine adults. Four children recovered, while fourteen died. Seven adults lived and two died. Resection of the invaginated portion was practised twelve times with only one recovery. An artificial anus was established in nine cases, followed by death in every instance.

* The Lancet, June 4, and 11, 1887. † New York Medical Journal, June, 1887.
‡ Verh. der deutschen Gesellschaft f. Chirurgie, 1885.

Treves† gives the general mortality in one hundred and thirty-three recorded cases as 72 per cent.; where reduction was easy it was 30 per cent., and when difficult 91 per cent. No one can look over these tables without noticing that the mortality was greatly influenced by the local conditions, as when the reduction was easy it was greatly reduced. This fact alone should convince us that laparotomy should be resorted to without delay as soon as a faithful attempt at reduction by rectal insufflation has demonstrated that reduction cannot be accomplished in any other way. The operation should be done as a first, and not as a last resort. As in cases of strangulated hernia the obstacles to reduction become more persistent as time advances, and the danger is augmented in proportion to the time which elapses until reduction is attempted. In reference to the time when the operation should be done, I can only caution against delay and make the positive statement that it should be done as soon as it has been shown that reduction cannot be effected by rectal insufflation. The age of the patient should not enter into consideration in deciding upon the propriety of an operation. Sands operated successfully upon an infant only six months of age, where the ordinary treatment by injection and inflation had been only partially effective in accomplishing disinvagination. The cæcum and appendix vermiformis and a small portion of ileum remained firmly fixed in the sheath and it required considerable traction force to release them.

Godlee† performed abdominal section successfully for invagination in a child nine months old, four days after the commencement of acute symptoms. In this case the invagination had progressed so far that the apex of the intussusceptum protruded at the anus.

Mr. Hutchinson‡ narrates the particulars of a successful abdominal section for intussusception in a child two years of age. The invagination had commenced in the ileo-cæcal region and during the course of one month had advanced to such an extent that the intussusceptum was extruded several inches at the child's anus. As rectal injections failed in reducing the bowel the abdomen was opened by an incision through the linea alba below the umbilicus and the intussusceptum was then easily found, and as easily reduced. The child made a rapid recovery.

As a rule, to which there should be no exception, the incision should be made in the median line as it furnishes the most ready access to the invagination and enables the operator to apply the various surgical resources with the greatest facility. For special indications a lateral

* The Lancet, December 13, 1884. † The Lancet, December 16, 1882.
‡ Medical Times and Gazette, Nov. 29, 1883.

incision can be made later. If the swelling has not been previously located by palpation or insufflation, it is usually not difficult to find the seat of obstruction. As soon as the invaginated part has been found it should be brought into, or as near to the wound as possible for careful examination, as the future action of the surgeon will be guided by the local conditions of the invaginated bowel. If on examination no evidences of gangrene are found efforts should be made to effect reduction.

a. Disinvagination.—In recent and especially acute cases, I am satisfied that the difficulties which resist reduction are not to be sought in the presence of adhesions as often as in the swollen œdematous intussusception. The same measures should be resorted to to enable reduction as in the preliminary treatment of a phimosis or paraphimosis. *The œdema and inflammatory swelling should be removed before any efforts at reduction are made. This can be readily accomplished by steady and uninterrupted manual compression of the invaginated portion.* As soon as the swelling has been reduced in this manner, reduction is attempted by making gentle traction upon the bowel above the neck of the intussuscipiens. Should this fail, inflation is practised, and as soon as the bowel between the returning cylinder and the sheath has become expanded, traction is again made upon the upper and lower ends. If this maneuvre fails to effect reduction, Rydygier's device* of making traction above and pushing from below can be tried. Rydygier also directs that reduction should be facilitated by inserting the finger between the intussusceptum and the intussuscipiens for the purpose of breaking up adhesions. Any one who has had much experience with such cases must have observed that the neck of the intussuscipiens grasps the bowel very tightly and that any such efforts as the introduction of a finger would be almost certain to result in a rupture of the bowel. If the treatment as above directed does not effect reduction the presence of adhesions must be suspected. These should be broken up not by the introduction of the finger, but by inserting and passing around the bowel a Kocher's director or a small probe. When the adhesions have been severed the efforts at reduction by traction and inflation are repeated.

Roser has suggested that after reduction has been effected the invaginated portion should be sutured to the abdominal wall for the purpose of preventing re-invagination. Under proper treatment it is not very likely that re-invagination will take place, and such fixation might subsequently result in another form of intestinal obstruction. Re-invagination can positively be prevented by shortening the me-

* Beilage, Centralblatt f. Chirurgie, 1887, p. 60.

sentery at the point of invagination by folding it upon itself in a direction parallel to the bowel and maintaining it in this position by a few catgut sutures.

Should repeated attempts at reduction fail, one of two courses of treatment may be pursued: 1. The establishment of an intestinal anastomosis. 2. Resection of the invaginated portion with or without circular enterorrhaphy. Resection of the invaginated portion, especially if the invagination is extensive, is a very grave undertaking, as it requires a long time for its execution, a matter of vital importance in these cases, and it involves the removal of important parts, and on these accounts should never be resorted to unless the invaginated parts show evidences of gangrene.

b. Intestinal Anastomosis.—An intestinal anastomosis between the bowel above and below the invagination by decalcified perforated bone discs can be made in fifteen minutes, and at once restores the continuity of the intestinal canal. As soon as the hydrostatic pressure above the obstruction has been removed by this operation, the danger of gangrene is diminished, and the bowel may again become permeable by a subsequent spontaneous reduction or by elimination of the intussusceptum. If the invagination remains permanently it does no particular harm as the obstructed portion has been excluded by the anastomosis and subsequently undergoes atrophic changes. In cases where the intussusceptum has advanced beyond the sigmoid flexure, it would become necessary after ligation to remove a part of it through the lower incision in order to render the bowel permeable below this point. I have in my possession a number of beautiful specimens of intestinal anastomosis obtained from animals in which I had made an artificial invagination and subsequently treated them by making an intestinal anastomosis, and I am firmly convinced that the same treatment will prove useful in practice.

Korcynski* reports an exceedingly interesting case where intestinal anastomosis was established spontaneously in a case of invagination followed by a cure. The patient was 41 years of age, and the symptoms of obstruction had lasted for six weeks but were completely relieved by the new opening. The existence of such an opening could be readily verified by digital exploration of the rectum. After the symptoms of obstruction had subsided, the exclusion of a part of the intestinal tract could be ascertained by insufflation of the rectum, which at once produced a tympanitic distension of the middle of the abdomen without distension of the colon. A similar but small com-

* Zwei Fälle von Darminvagination langer Dauer. Virchow u. Hirsch's Jahresbericht, B. 11, p. 193, 1881.

munication has been found on post-mortem examination as in the case reported by Gerry and referred to in another part of this paper.

c. Resection.—The only indication for resection is furnished by gangrene of the invaginated portion. The extent of the gangrene is immaterial in reference to the advisability of making a resection, as a small gangrenous spot necessarily would lead to perforation and death from septic peritonitis, unless this radical measure is adopted. The resection must always include the entire intussusceptum, but not necessarily the entire sheath. The first evidences of gangrene upon the external surface of the bowel appear about the neck of the intussuscipiens, and when the invagination is extensive and the lower portion of the sheath presents a healthy appearance it is only necessary to resect the neck of the intussuscipiens and the intussusceptum which after division and isolation about the neck can be drawn out and removed. The bowel above and below the proposed points of section should be tied with a rubber band to prevent fæcal extravasation during the operation. The mesenteric attachments must be tied in small sections with fine silk ligatures, as tying in larger sections or with catgut is liable to be followed by hæmorrhage. After the resection has been made it becomes a serious question how to proceed farther. Shall the continuity of the intestinal canal be restored at once by suturing or shall an artificial anus be established? When the resection involves the ileum above and the colon below, it is exceedingly difficult to restore the continuity of the intestinal canal by circular enterorraphy on account of the difference in the lumina of the bowel to be united. As ileo-cæcal invagination is the most common form, it is evident that as a rule some other plan must be followed. Under these circumstances one of two methods of procedure can be chosen. The colon at the point of division is inverted to the extent of an inch or more, and closed by making a few stitches of the continued suture which should embrace only the serous and muscular coats, and the iliac end is implanted into a slit, corresponding in size to the circumference of the bowel, made in the colon on the side opposite to the meso-colon at a point just below the closed end. Fixation is most effectually secured by rubber ring and two inversion sutures as described in my paper read at the last meeting of the International Medical Congress, to which should be added as a matter of precaution a superficial continued suture. If lateral implantation cannot be readily done an equally efficient method consists in closing both ends and establishing the continuity of the intestinal canal by lateral apposition with decalcified perforated bone plates in the same manner as has been described under the head of intestinal anastomosis. Restoration of the conti-

nuity of the intestinal canal after resection of an invaginated bowel by lateral implantation or lateral apposition requires much less time than a circular enterorrhaphy, while both operations secure better conditions for definitive healing than circular enterorrhaphy, and on these accounts should under these and similar circumstances be preferred to the latter procedure.

In cases of colic invagination requiring an extensive resection approximation of the two ends is not possible on account of the distance they are separated from each other and the comparatively slight immobility of this part of the intestine. In such a case lateral implantation is impracticable for the same reasons. The choice lies between the establishment of an artificial anus and lateral apposition; the former should never be made, as in case of recovery of the patient the fæcal fistula would remain as a permanent condition without any prospects of an ultimate cure. The continuity of the intestinal canal can be restored at once in these cases by making an ileo-colostomy, or a colo-colostomy by lateral apposition with perforated decalcified bone plates, according to the location or extent of the resection.

Wassiljew * reports a very interesting case of resection for invagination which ultimately terminated in recovery. The patient was a man, aged twenty-five years, who was seized with abdominal pain and vomiting. As the symptoms of obstruction did not yield to ordinary treatment, laparotomy was performed on the second day. On opening the abdominal cavity a swelling was readily detected in the right hypogastric region. This swelling was drawn forwards, and found to be an extensive invagination of the ileum into the colon. As reduction could not be accomplished an elastic ligature was tied around the gut in two places and the ileum and mesentery were divided. Then the invaginated portion was readily withdrawn and about seventeen inches were resected. The abdominal cavity was washed out with a solution of sublimate and the cut ends of the gut were fixed by sutures to the abdominal wound. Much gas and fæcal matter escaped, when the ligatures were united. During the sixth week an operation was performed for the cure of the artificial anus. About six inches more of the intestine were resected and the cut ends united by Czerny's suture. On the third day the bowels moved, but on the fifth day the fæcal discharges again escaped through the wound. The different attempts to close the fistulous opening failed. Digital exploration showed that a spur was beginning to form. To this spur a pressure forceps was applied; it fell off on the third day; ultimately the fistula closed.

* Invaginatio ileo-cæcalis. Laparotomia, Resectio intestini. Heilung. Centralblatt f. Chirurgie, 1888, No. 12.

3. *Volvulus.*

Volvulus or twisting of a loop of intestine around its axis constitutes a well-defined form of intestinal obstruction. This pathological condition can only occur where the mesentery of the bowel is of considerable length and is therefore most frequently met with in the lower portion of the ileum and at the sigmoid flexure of the colon. This condition as compared with some other forms of intestinal obstruction is quite rare, as in one thousand five hundred and forty-one cases of obstruction from different causes collected by Leichtenstern * and analyzed with special reference to the anatomical cause of the obstruction, after deducting one hundred and seventy-eight due to carcinoma, thirty-three cases only were due to twisting of the bowel, this including twists of both the sigmoid flexure and the ileum. Upon another page the same author gives the result of his examination of seventy-six cases of volvulus which he has collected, and of this number the lesion was found in forty-five cases in the sigmoid flexure, in twenty-three cases in the ileum, in eight cases the jejunum and ileum combined. A simple twist of a long loop of intestine one-half to once around its axis does not necessarily lead to intestinal obstruction. I made a number of experiments on animals by rotating a loop of intestine from one-half to twice around its axis and keeping it fixed in this position by suturing at the base of the loop, and yet no obstruction was produced. These experiments are interesting, inasmuch as they show that the primary constriction produced in making and maintaining the volvulus which was sufficient to cause venous engorgment in the twisted loop must have been only of short duration, the disappearance of the constriction being undoubtedly due to the gradual yielding of the sutured parts, while the faulty axis of the twisted loop was maintained by the sutures the circulation improved and remained in a sufficiently vigorous condition to adequately nourish the most distant portions of the volvulus. In most cases where I made a volvulus artificially the animals did not suffer from intestinal obstruction, and yet the examination of the specimens showed that the twist had remained. The shortness of the mesentery had undoubtedly a great deal to do with the restoration of the circulation in the twisted loop, as this portion of the bowel immediately after fixation always presented a cyanosed appearance. While it was found difficult to force fluid through the specimen of a volvulus, during life, propulsion of the intestinal contents by peristaltic action was carried on in a satisfactory manner, as the bowel above the volvulus was not dilated, and contained no

* Ziemssen's Cyclopædia of the Practice of Medicine. Amer. Transl., vol. iii.

abnormal amount of fluid, and the animals manifested no symptoms indicative of intestinal obstruction. In cases where death has been produced by volvulus the post-mortem appearances will show that the obstruction was caused not so much from mechanical causes as from the secondary pathological conditions in the twisted loop. The abnormal length of the mesentery found in these cases precludes the possibility of partial or complete spontaneous reposition, and the consequence is that the parts involved in the volvulus become the seat of serious vascular disturbances which lead to œdema and paresis. These secondary conditions are followed by distension of the intestine and accumulation of intestinal contents which cannot fail in aggravating the mechanical difficulties which initiated the obstruction. A number of these points are well illustrated by a case of volvulus reported by Wilson.* A boy, nineteen years of age, without any premonitory symptoms was suddenly seized with symptoms of acute intestinal obstruction. Colicky pains and persistent vomiting were the most conspicuous symptoms. Tenderness over the umbilicus and slight fullness between pubic arch and umbilicus. Whole abdomen tympanitic. Pulse rapid and small. Skin pale and cold. The patient died thirty-two hours after the commencement of the attack. The necropsy showed moderate distension of the intestines, which were also found congested. Four or five loops of the small intestines occupying the hypogastrium were of a deep purplish black color, and gangrenous. They were also considerably more distended than the surrounding gut, and taken together they compared exactly with the outline of the circumscribed tympanitic distension observed during life in this region of the abdomen. On careful examination these blackened coils of intestine were found to constitute a portion of the ileum, five feet in length, tightly twisted upon itself in its mesenteric axis. The lower point of crossing was five inches above the ileo-cæcal valve. At the point of crossing of the upper and lower end of the volvulus the intestines were flattened and, with the corresponding mesentery tightly twisted upon itself, forming a firm, hard cord-like pedicle about an inch and a half in length, and a little more than one-third of an inch in diameter. The twist was from left to right, and amounted to a complete turn upon the vertebro-enteric axis of the mesentery. The gangrene and rapidly fatal termination in this case were due to the compression of veins at the base of the volvulus and not to the obstruction. In reference to the causation of volvulus a number of theories have been advanced. All authors are agreed upon one point, in that the mesentery must be of abnormal length.

* Amer. Journal Med. Sciences, July, 1878, p. 78.

Grawitz* asserts that the immediate cause of a volvulus is to be found in an accumulation of intestinal contents above a constricted portion of bowel. The distended portion of intestine above the seat of constriction undergoes elongation and that this elongated portion then rotates around its axis. Henning† studied the ætiology of volvulus experimentally. He ligated the intestine in animals firmly and then injected water above the seat of obstruction. In the small intestines the distended and elongated coils above the ligature always showed a tendency to rotate upon their vertebro-mesenteric axis, and thus a volvulus was produced. In the large intestines on account of the shortness of the mesenteric attachment, the same experiment caused rupture of the bowel before a volvulus could be produced. He collected a number of cases of volvulus scattered through literature where in the post-mortem description of the twisted bowel it is distinctly stated that the lumen of the intestine was narrowed by some form of acquired or congenital stenosis. While it cannot be denied that chronic obstruction may be a direct or indirect cause of volvulus by producing not only elongation of the intestine, but also of the mesentery above the seat of obstruction many cases have been reported where no such condition was found, and where, therefore, the lesion was due to other causes.

Nieberding‡ has recently called attention to another cause of volvulus. He has reported a case which occurred in Bumm's practice where after an ovariotomy a volvulus of the small intestine occurred which proved fatal after a few days. During the operation, the omentum, which was adherent to the cyst, was separated and a portion was excised. The necropsy showed that the raw surface of the omental stump had formed an adhesion to a loop of the small intestine and above the fixed point a volvulus was found. He reported another and somewhat similar case which came under his own observation. A large cysto-sarcoma of the left ovary was removed in a girl twenty-nine years of age. Before closing the wound it was noticed that the omentum was so short that the intestines could not be covered by it in the region of the incision. At the end of the second day symptoms of acute obstruction set in, the temperature remaining normal. As the symptoms increased in gravity and the ordinary treatment proved fruitless, the wound was opened and a loop of intestine was found adherent to the left margin of the peritoneal wound, and after this was

* Virchow u. Hirsch's Jahresbericht, 1876, B. I, p. 284.

† Beiträge zur Kenntniss der Pathogenese des Volvulus. Dissertation. Berlin, 1883.

‡ Beitrag zur Darmocclusion nach Ovariotomie. Centralblatt f. Gynekologie, 1888, No. 12.

separated a volvulus was detected. The bowel was untwisted and its contents forced into the segment farther down beyond the seat of obstruction and the detached loop pushed beyond the reach of the abdominal wound and the abdomen closed. The day after the operation the intestinal canal appeared to be permeable as gas escaped per rectum, but evidences of peritonitis set in and the patient died with symptoms of collapse. He believes that the peritonitis was produced by the obstruction.

G. Braun* reports a case of volvulus in a woman occurring at the end of pregnancy and believes that the pressure of the gravid uterus upon the sigmoid flexure produced the obstinate constipation which preceded the attack and gave rise to elongation of the mesentery and bowel above the seat of compression to a sufficient extent to cause volvulus. At the time she was admitted into the hospital the abdomen was enormously distended, nausea but no vomiting. On the next day labor pains set in and she was delivered of a dead child. On the same day vomiting commenced and a tendency to collapse was observed. The day after delivery she complained of intense pain in the abdomen, difficulty in breathing, and great prostration, and in a few days she died, the symptoms pointing to an intestinal obstruction remaining constant. At the necropsy the sigmoid flexure and its mesentery were found greatly elongated and rotated twice around its axis. That volvulus is not a frequent complication of pregnancy becomes apparent from the statement of Braun, that this was the first case in sixty thousand deliveries which had come under his own observation.

Kuettner† had unusual opportunities to study this form of intestinal obstruction, as four cases came under his own treatment in the short space of two and a half years. As predisposing causes he mentions advanced age, emaciation, as the latter is attended by an absence of fat in the omentum and mesentery which renders the peritoneal cavity more spacious. Abnormal length of mesentery and intestinal tract is also enumerated as an important element in the causation of volvulus. Among the exciting causes he mentions as the most important unequal distribution of intestinal contents and exaggerated peristalsis. He never observed peritonitis in any of his cases even if life was prolonged for five or six days. He believes that in these cases the rapid fatal termination is due to pressure upon the sympathetic nerves which causes paralysis and destroys life in the same manner as peritonitis.

* Enterostenosen in ihrer Beziehung zur Gravidität und Geburt. Wiener Med. Wochenschrift, 1885, No. 24.

† Ueber innere Incarcerationen. Virchow's Archiv., B. XLIII, p. 478.

He asserts that the complicated forms of knotting of the intestines which are still described in the text-books as rare but distinct forms of obstruction are only varieties of volvulus.

Treatment.—Treves in his paper on "The Operative Treatment of Intestinal Obstruction* claims that this form of obstruction is only aggravated by forcible rectal injections, as such a procedure will tend to tighten rather than to relax the twist. Of the operative treatment he says that simple laparotomy is an unpromising procedure, but that in the future he will make the incision in the median line, puncture the gut, and attempt its reduction; if this fail, or the result appear unsatisfactory, he will evacuate the involved gut through an opening in the summit of the flexure, unfold the volvulus, and establish an artificial anus, using the opening just mentioned for that purpose. In some cases of volvulus the rotation around the vertebro-mesenteric axis is often less than one complete circle and before the involved bowel has become considerably changed by the twist a reduction might be effected by dilating and elongating the bowel below the seat of obstruction, thus bringing the same causes to bear which have produced the displacement, but in an opposite direction. Careful inflation with hydrogen gas soon after the obstruction has occurred will be a harmless procedure, and in favorable cases might lead to the desired result. That this method of reduction should not be tried after the twisted loop has become softened and greatly distended by intestinal contents requires no explanation. Of all forms of intestinal obstruction volvulus leads most rapidly to a fatal termination. This fact alone is a sufficient warning to lose but little time by temporizing measures. If life is to be saved prompt operative treatment must be adopted. After the symptoms have become sufficiently well marked, if insufflation proves unavailing, laparotomy should be resorted to at once without reference to the time which has elapsed. If the abdomen is opened before the bowel has undergone serious pathological changes reduction will not be difficult, and as the intestine is otherwise in a healthy condition the prospects of a favorable termination are good. In such a favorable case it would not only be prudent, but imperative to resort to means to prevent a recurrence of the volvulus. As an elongated mesentery plays the most important rôle in its production the best prophylactic means against a recurrence would be to shorten the mesentery. Resection of the mesentery is out of question, as such a procedure might result in gangrene of a corresponding portion of the gut. Shortening of the mesentery, however, can be effected by folding and suturing the mesentery in the same manner as

* The British Medical Journal, August 29, 1885.

has been described in treating of the operative treatment of invagination. Such an expedient would shorten the mesenteric attachment without interfering with the intestinal circulation. If the twisted portion of the intestine presents evidences of gangrene, resection becomes necessary, and after it has been done the continuity of the intestinal canal should be restored by circular enterorrhaphy or by lateral approximation with decalcified perforated bone plates. If reduction cannot be accomplished without evacuating the distended bowel an incision should be made on its convex surface at the summit of the loop, and its contents removed by pouring it out, taking, of course, all the necessary precautions not to soil the peritoneal cavity. After this has been done the visceral wound should be sutured and another attempt made at reduction. If this does not succeed and the symptoms are such that the necessary time required for resection would prove an element of danger, the volvulus should be left and the obstruction rendered harmless by establishing a communication between the bowel above and below the volvulus by lateral apposition with decalcified perforated bone plates.

4. *Obstruction by Flexion and Adhesion.*

Every pathologist who has carefully examined the intestinal canal of persons who have acute peritonitis must have noticed the presence of numerous flexions caused by visceral and parietal adhesions, and yet such patients seldom exhibited well marked symptoms of intestinal obstruction during life. I have observed the same conditions in animals during my experimental work on the intestinal canal and seldom found that simple flexion gave rise to intestinal obstruction. I have made numerous flexions when performing operations for establishing intestinal anastomosis, and in most instances satisfied myself by examination of the specimens that fluids passed them without great difficulty. If the bowel at the point of flexion remains free, certain portions of its wall will yield to pressure from within of the fluid intestinal contents, and gradually the lumen of the bowel will become restored. If, on the other hand, the entire circumference of the bowel at the point of flexion has become fixed and immovable by inflammatory adhesions or other pathological products, a compensating dilatation becomes impossible and flexion becomes a direct and serious cause of obstruction. In recent cases of flexion of course the circumference of the lumen of the bowel at the point of flexion is equal in size to that above or below the obstruction. The obstruction in such cases is not caused by stenosis, but by compression of the distal limb of the flexion by the intestinal contents in the proximal portion, thus

causing a valvular closure not at, but just beyond the seat of flexion. This is more likely to take place if the apex of the flexed portion of the bowel is adherent to some fixed point, as in this case compensatory dilation of the intestinal wall at a point corresponding to the apex of the flexion cannot take place. When a flexion has existed for a long time without having given rise to symptoms of obstruction, it finally may cause occlusion by a cicatricial stenosis at the seat of flexion due to a circumscribed plastic inflammation and cicatricial contraction of the inflammatory product. Such a case came under the observation of Obalinski.* A boy, eighteen years old, had suffered from typhoid fever eight months before the attack of intestinal obstruction set in. Some time before the acute symptoms appeared he suffered from pain in the abdomen which gradually increased in intensity until the clinical picture of obstruction was well marked. On the eighth day after the attack the abdomen was opened by a median incision. Distended and collapsed intestinal coils came within easy reach. The obstruction consisted of a rectangular flexion of the small intestine caused by a pseudo-ligament the size of a lead pencil. After division of this band and straightening the bowel, it was seen that it was considerably contracted at the point of flexion by a circular cicatrix, but as it was permeable nothing further was done. The boy was discharged cured four weeks after the operation. That the pressure of intestinal contents in the proximal bar is exerted mainly upon the spur which forms in acute flexions between the two bars, is well shown by a specimen described by Birkett† where an intestinal anastomosis was established spontaneously by ulceration between the approximated adherent tubes at the point of compression, so that the intestinal contents passed directly from one intestine to the other through this "fistula bimucosa" instead of traversing the loop. The patient was a man, aged fifty-eight, who six months before his death had presented a strangulated hernia that had been reduced by taxis. When the flexion is very acute, the spur formed by the apex of the approximated walls of both bars acts like a valve in closing the lumen of the distal bar under the influence of the hydrostatic pressure from the accumulation of intestinal contents above the seat of flexion. Nicaise‡ has reported a typical case of this kind. A man, aged twenty-five years, was operated upon for strangulated hernia five years before the attack of intestinal obstruction. Since the herni-

* Weitere Beiträge zur Laparotomie bei inneren Darmocclusionen. Wiener Med. Presse, 1886, Nos. 4–12.

† Pathological Soc. Transactions, vol. x. 1859.

‡ Bulletin et Mem. de la Soc. de Chirurgie, Paris, 1880, p. 583.

otomy he had suffered frequently from attacks of vomiting and constipation with abdominal pain. The last attack was so severe that enterotomy was performed. He died the next day. The necropsy revealed an acute flexion which had become permanent by old adhesions. The flexion was so acute that the mucous membrane at its apex constituted a kind of valve across the lumen of the bowel. After liberation of a flexed bowel the seat of an intestinal obstruction it becomes a step in the operation to resort to such prophylactic measures as may appear necessary to prevent a return of the malposition and to cover as far as possible the peritoneal defects which have been made during the separation of the loop. Winslow* reports a case in point. In this case a loop of the small intestines was found firmly adherent in the pelvis over an area of six inches and sharply flexed. After it was carefully detached it was found denuded of peritoneum over a small space. The continuity of the peritoneal surface was restored by applying a number of sutures transversely to the long axis of the bowel. It is distinctly stated that this portion of the bowel was deeply congested, hence the seat of the texural changes consequent upon the obstruction. In most cases of flexion which have been described in connection with intestinal obstruction the flexed bowel was found either in the pelvis near the internal inguinal rings, or in the ileo-cæcal region, localities where localized peritonitis is most frequently met with. If, after the reduction of a strangulated hernia the replaced loop of intestine is or becomes the seat of a plastic peritonitis it forms an attachment to the abdominal parietes or viscera with which it comes in contact. In case the adhesion thus formed remains firm and is not drawn out in the form of a band, or a flexion may form by the free portion of the bowel changing its relative position, and the two bars of the flexion thus formed, when in close contact and the seat of the same plastic inflammation become adherent and the flexion becomes permanent. If the continuity of the bowel cannot be restored by separation of the adhesions in the operative treatment of obstruction caused by flexion and the tissues at the seat of obstruction present no evidences of gangrene an anastomosis between the two bars of the flexion should be made in preference to resection and circular suturing. Circumscribed spots of gangrene can be excised and the wound sutured transversely to the long axis of the bowel as this will cause no stenosis and will tend to correct the faulty position of the bowel. As in cases of constriction by bands, if it is found difficult to separate the adhesions no attempt should be made to liberate the gut until a rubber ligature has been applied to each bar of the

* Amer. Journal Med. Sciences, vol. xli., p. 411.

flexion to prevent fæcal extravasation should the bowel be ruptured during the separation.

Adhesions.—Quite recently a number of abdominal surgeons have published their experience in reference to the occurrence of intestinal obstruction after laparotomy. A number of cases of intestinal obstruction which occurred soon after ovariotomy were found to have been caused by extensive parietal adhesions of the intestines, hence the question has been discussed how such adhesions are to be prevented.

P. Mueller* has advised that in difficult ovariotomies adhesions of the intestines amongst themselves and with the abdominal walls should be prevented by avoiding external compression by bandages and by filling the abdominal cavity with a physiological solution of common salt (0.7 per cent.) For the purpose of limiting peritoneal absorption he suggests that the solution should be introduced from time to time and finally should be withdrawn through the drainage tube.

Olshausen† has found in all the cases of intestinal obstruction after ovariotomy that occurred in his practice that the obstruction was caused by adhesion of an intestinal loop to the surface of the stump. Mueller's prophylactic treatment he considers rational, especially in cases where the operation is attended by considerable hæmorrhage. Schatz holds that visceral and parietal adhesions of the intestines after ovariotomy are a much more frequent condition than is generally believed. He is of the opinion that serious consequences do not necessarily follow such condition. Gusserow asserts that adhesions are frequently found on making a second laparotomy in the same patient without having produced any outward symptoms.

Kaltenbach now uses a 1–6000 solution of sublimate in place of carbolic acid solution, and since he has made this change he has not observed a case of intestinal obstruction in fifty-four consecutive larparotomies, while of twenty-four cases where carbolic acid was used he lost two cases from this cause. Kruckenberg attributes to the use of sublimate an influence in causing plastic adhesions and asserts that since he has abandoned this agent he has had no cases of internal obstruction after ovariotomy. Sänger's experiments appear to prove that for the formation of a firm and permanent adhesion only one wounded surface is necessary. Schwarz believes that parietal adhesions along the internal surface of the abdominal wound are of frequent occurrence because intestinal loops are caught in the furrow of

* Zur Nachbehandlung schwerer Laparotomien. Archiv. f. Gynaekologie, B. XXVIII, Heft 3.

† Verh. der Deutschen Gesellschaft für Gynækologie, 1886.

peritoneum along the line of suturing, where an additional irritation is met with on the part of the sutures.

Martin* as early as 1865 reported two cases which illustrate one of the dangers which follow puerperal pelveo-peritonitis. In one case the peritonitis followed a manual separation of the placenta. The patient made a rapid recovery, but six weeks latter symptoms of acute intestinal obstruction developed from which the patient died on the fourth day. On post-mortem the cause of obstruction was found to be a firm pseudo-membranous band which connected the anterior surface of the cæcum with a coil of the small intestine. In the second case a metro-peritonitis followed a normal delivery which, however, yielded to proper treatment on the fifth day. During the seventh week after delivery symptoms of acute intestinal obstruction set in and the disease proved fatal after a few days. A similar condition as in the first case was found at the post-mortem.

Hirsch† presents at length the results of his observations and researches on intestinal obstruction after ovariotomy to one of three causes: 1. Adhesions of an intestinal loop to abdominal incision and occlusion from the traction of the cicatrix. 2. Aseptic plastic peritonitis which by causing extensive adhesions results in immobilization of a considerable portion of the intestinal canal which leads to coprostasis and complete obstruction. 3. Impaction of an intestinal loop between a pedicle, treated by the extra peritoneal method, and the abdominal wall. Sir Spencer Wells reported eleven deaths from this cause in 1000 cases of ovariotomy. Usually the obstruction occurs soon after the operation, but several years may elapse before the accident takes place. The symptoms are the same as in the obstruction from other causes.

The prognosis in cases of obstruction from intestinal adhesions is extremely unfavorable. Of the fourteen cases collected by the writer, only one recovered after secondary laparotomy. In view of the great mortality which attends this the most serious complication after laparotomy it is exceedingly important to resort to proper prophylactic measures in all cases of intra-abdominal operations. In the first place, when the operation is done in an aseptic peritoneal cavity all irritating antiseptic solutions should be kept from coming in contact with the peritoneum, as their local irritant action might produce a plastic peritonitis. The peritoneum should not be unnecessarily bruised or sponged, as a slight traumatic irritation may be productive of a cir-

*Zwei Fälle von Darmeinklemmung durch Exsudatfäden nach Wochenbetten. Monatsschrift für Geburtskunde, July, 1865.

†Archiv f. Gynækologie, B. XXXII., Heft 2.

cumscribed adhesive inflammation. Finally it should be the aim of the surgeon to restore, if possible, the continuity of the peritoneal surface should any defects be found during or caused by the operation before the abdomen is closed. Adhesion of the intestines to the abdominal incision can be prevented by spreading the omentum carefully over the intestines the whole length of the incision. Limited defects can be readily closed by suturing. The cut surface of the pedicle after ovariotomy should be covered by stitching the peritoneum over it. The stump after supra-vaginal amputation is treated in a similar manner. Parietal and visceral defects not amenable to suturing can be covered with an omental graft which is stitched to the margins of the defect with catgut sutures. In cases of intestinal obstruction due to extensive adhesions after operations, or attacks of circumscribed peritonitis, it is essential to resort to early operative treatment which consists in separating the adhesions and in restoring peritoneal defects as far as possible for the purpose of guarding against similar attacks in the future. After the intestine has been liberated it is advisable to place the detached portion in some part of the abdominal cavity where a similar condition is less likely to occur.

5. *Strangulation by Ligamentous Bands or Diverticula.*

Ligamentous bands resulting from old adhesions are usually found in parts of the abdominal cavity most frequently the seat of peritonitis, viz : in the pelvis and the ileo-cæcal region. Their formation can generally be traced to a broad parietal adhesion which by the peristaltic action of the free portion of the intestine has become elongated and often narrowed to a delicate cord. It becomes a cause of obstruction when the migrating or free end forms an attachment to some fixed point which renders then the band tense and unyielding, and in case a loop of intestine becomes ensnared underneath it strangulation takes place in the same manner as in strangulated hernia, the constricting cord by its pressure causing venous engorgement below the constriction and by the increased peristaltic action of the proximal limb of the loop forcing intestinal contents into, but not through, the constricted loop. As in hernia, an intestine may have become adherent and fixed underneath such a band for an indefinite period of time without strangulation taking place, as long as the immediate causes of strangulation are absent. Any causes which disturb the mechanical relations still further in such a case, as a fall, lifting, coughing, the administration of an active cathartic, etc., may bring on an acute attack of intestinal obstruction. The history of cases of intestinal

obstruction due to the presence of a ligamentous band frequently refers to an attack of peritonitis through which the patient passed perhaps years before and as frequently alludes to one of the above mentioned proximate causes as preceding the attack of intestinal obstruction. A displaced neck of hernial sac may cause obstruction in the same manner as a ligamentous band. Kurz* treated such a case successfully by laparotomy. The patient, a man thirty-three years of age, had been the subject of a small inguinal hernia for several years without causing much inconvenience, when symptoms of acute intestinal obstruction set in, the inguinal canal was carefully examined and was found empty. The symptoms of obstruction were very grave, including a subnormal temperature and fæcal vomiting at the time the operation was performed. Digital exploration of the ileo-cæcal region through a median abdominal incision led to the discovery of a ring in which the colon had become ensnared. Reduction by moderate traction was found impossible, and it was found necessary to incise the ring at two points when the bowel which was deeply congested was readily withdrawn. The ring was found displaced four inches from the internal ring. The patient made a rapid and satisfactory recovery. In other instances the contents of the hernia, either the omentum or the intestinal loop, when in a condition of plastic inflammation may lead to the formation of a ligamentous band when either of these structures become attached too near the intestinal ring the adhesion which forms lengthening out until it is attached to some other fixed point. Obre† described the post-mortem appearances of such a case. The strangulated loop had wandered to near the xyphoid cartilage; while between it and the inguinal ring a cord seventeen inches long was found. A band of constriction can also be formed by the margins of an opening in the mesentery or omentum in which a loop of intestine can become strangulated. In such cases it becomes necessary after reduction has been effected to close the opening by sutures to prevent a possible relapse of the obstruction from the same cause. An adherent portion of omentum in the course of time may become drawn out into a narrow twisted cord which may become a cause of internal strangulation. In operating for intestinal obstruction caused by constricting bands it is always necessary after relieving the point of constriction first found to search for additional bands as it is not unusual to find more than one. Obalinski‡ made a laparotomy for intestinal obstruction on the third day after the appearance of acute symptoms.

* Deutsche Med. Wochenschrift, March 25, 1885.

† Pathological Society Transactions, 1851, p. 95.

‡ Wiener Med. Presse, No. 4–12, 1886.

On introducing his hand through a median incision he felt in the right iliac region distended and empty coils, and by tracing the latter in an upward direction found as the cause of obstruction two bands each the size of a goose-quill extending from the cæcum to the abdominal wall between which a loop of intestine 30 ctm. in length had become strangulated. Both bands were ligated and divided. Bowels moved on the fourth day and patient was discharged cured in two weeks.

Fowler* has met with two cases where at the autopsy a second band was found close to the divided one.

Another frequent location for bands is in the umbilical region where the remains of the umbilical artery may become a cause of constriction. Polaillon,† in a young man opened the abdomen by lateral incision on right side for intestinal obstruction one week after the appearance of the first symptoms. As the patient was the subject of an inguinal hernia both inguinal canals were examined by digital exploration through this incision, but nothing was found to explain the obstruction. The incision was enlarged and the whole hand introduced, and after careful exploration a falciform fold was found to the left of the median line which extended from the left inguinal ring toward the umbilicus. Between the band and the abdominal wall a sac was found which contained numerous coils of intestine. The whole intestine was carefully examined and finally an empty loop about ten inches in length was found. The cause of strangulation was the peritoneal band, reduction having taken place by the introduction of the hand. The band was not divided for fear of hemorrhage. The patient recovered after a slight attack of peritonitis. Intestinal obstruction by a constricting band furnishes the simplest and most favorable conditions for early operative treatment by abdominal section. Without prompt surgical treatment a fatal termination is almost inevitable as death results either from the mechanical effects of the obstruction or the constriction produces gangrene under the sharp margin of the band followed by perforation and death from septic peritonitis. An operation undertaken before the strangulation has caused great abdominal distension and serious texural changes by pressure or constriction would be almost sure to be rewarded by success. Two cases of intestinal obstruction caused by ligamentous bands recently reported by Bull‡ illustrate in a most striking manner

* The Lancet, June 30, 1883, p. 1120.

† Gazette Médicale de Paris, April 25, 1885.

‡ Report of Cases of Intestinal Obstruction Treated by Laparotomy. Gaillard's Medical Journal, March, 1888.

the importance of early operative interference. Both cases were treated by laparotomy, and the difference in the results obtained was plainly traceable to the length of time which had intervened between the onset of the disease and the operation. In the first case the operation was delayed until the eleventh day and during the separation of the band a gangrenous spot in the bowel gave way, followed by fæcal extravasation. The circumscribed gangrenous patch was excised, making a wound an inch in length, and parallel to the long axis of the bowel, which was closed with twelve Lembert sutures. Death twelve hours after operation. In the second case laparotomy was performed almost under identical circumstances, but the strangulation had existed only six days. In this case the operation was limited to the removal of the cause of obstruction, as the constricted bowel had not undergone irreparable damage and the patient recovered. The operative treatment of the obstruction in this form of intestinal strangulation is usually not attended by any difficulties. The band of constriction, whatever its location or mode of origin, may be is traced to both fixed points of attachment and excised between two ligatures. This not only relieves the strangulation, but prevents a possible recurrence of a similar attack from the same cause. In some instances however, the local conditions may be more complicated. Reali met with a case where it was found impossible to liberate the intestine from a constricting band, and where he divided the intestine at the point of constriction and reunited the ends again by circular suturing, and his patient recovered. If on careful examination the conditions at the seat of constriction are such as to make it probable that the gut is the seat of gangrene from compression underneath the band or that the separation of the band from the intestine is not readily accomplished, no attempts should be made to liberate the intestine until measures have been employed to guard against fæcal extravasation in the event the gut should be ruptured. This precaution consists in emptying the intestine on each side of the constriction to a distance of from two to four inches by displacing its contents in its interior between the thumb and index finger and applying a rubber ligature which is passed through the mesentery with a pair of hæmostatic forceps. The ligatures are not removed until the bowel has been liberated, and if it is injured or presents evidences of gangrene not until its continuity has been restored by suturing or excision, or by establishing an anastomosis after resection.

From a surgical standpoint in the causation and treatment of intestinal obstruction the appendix vermiformis must be looked upon as a diverticulum. The appendix vermiformis may become a cause of ob-

struction when it is of abnormal length and supplied by a long mesentery, and when it is transformed into an unyielding band by fixation of its free extremity to some firm point by adhesive inflammation. Greves* reports such a case. A boy, six years of age, who had suffered frequently from attacks of constipation lasting from a few days to a week or fortnight was seized with violent pain in the abdomen and other symptoms of acute internal strangulation. On the fourth day the pain was referred to the iliac region, where a resonant swelling could be located. As the usual means proved of no avail, laparotomy was performed on the fifth day. About twelve inches of the small intestines were found to be tightly strangulated by an abnormal appendix vermiformis, whose free end had become fixed to the iliac fossa, forming a complete ring, through which the small intestine had slipped and became strangulated. Strangulation was relieved by division of ring. Patient had not a single bad symptom after the operation. Excision of the appendix vermiformis, when the cause of obstruction, should always be practiced with a view of preventing a similar attack from the same cause. As in such cases the process has undergone elongation by traction it is sufficient to apply a ligature near its base and then remove it by excision.

Quite a number of cases of intestinal obstruction are on record where the obstruction was caused by a diverticulum, and in a number of these cases the strangulation was successfully treated by laparotomy. To the same class belong bands, the remains of obliterated omphalo-mesenteric vessels.

In 1851 Parise† published his paper on a new cause of strangulation, in which he claimed that he was the first one to show that strangulation may take place from constriction by a diverticulum. The same year Bonvier‡ described a case where a diverticulum of unusual length springing from the ileum three feet above the ileo-cæcal valve encircled a loop of the small intestine so firmly as to give rise to complete obstruction. Where the diverticulum joined the ileum the lumina of both were equal in diameter, but the diverticulum tapered towards its end, ending in a bifid extremity, adherent to intestinal coils. Omentum and abdominal wall furnished the unyielding points. The constriction was not very firm and reduction could have been readily effected had an abdominal section been made.

* The Lancet, December 6, 1884.

† Mémoire sur le mécanisme de l'etranglement intestinal par un noeud diverticulaire. Bull. del'Acad. de Med., 1851, p. 373.

‡ Note sur un Cas de l'etranglement interne de l'intestin Grêle par un diverticule de l'ileon. Gaz. des Hôpitaux, 1851, No. 87.

Fitz* in an exhaustive article on "Persistent Omphalo-mesenteric Remains," has collected all material facts pertaining to Meckel's diverticulum with especial reference as a cause of internal strangulation. As a result of a careful study of this subject he has come to the following conclusions:

1. Bands and cords as a cause of acute intestinal obstruction are second in importance to intussusception alone.

2. Their seat, structure, and relation are such as frequently admit their origin from obliterated or patent omphalo-mesenteric vessels, either alone or in connection with Meckel's diverticulum, and oppose their origin from peritonitis.

3. Recorded cases of intestinal obstruction from Meckel's diverticulum, in most instances at least, belong in the above series.

4. In the region where these congenital causes are most frequently met with, an occasional cause of intestinal strangulation, viz: the vermiform appendix, is also found.

5. It would seem, therefore, that in the operation of abdominal section for the relief of acute intestinal obstruction, not due to intussusception, and in the absence of local symptoms calling for the preferable exploration of other parts of the abdominal cavity, the lower right quadrant should be selected as the seat of incision. The vicinity of the navel and the lower three feet of the ileum should then receive the earliest attention. If a band is discovered, it is most likely to be a persistent vitelline duct, i. e., Meckel's diverticulum, or an omphalo-mesenteric vessel either patent or obliterated, or both these structures in continuity. The section of the band may thus necessitate opening the intestinal canal or a blood vessel of large size. Each of these alternatives is to be guarded against, and the removal of the entire band is to be sought for, lest subsequent adherence prove a fresh source of strangulation.

According to Schröder† a diverticulum is only supplied with a mesentery when it springs from the lateral aspect of the intestine, or near the mesenteric attachment. Diverticula on the convex surface of the bowel are free and supplied with vessels from the intestinal wall. Meckel found in several specimens a valve at the junction of the diverticulum with the bowel, and in one instance Phoebus found the opening of the diverticulum into the bowel crossed by a bridge of tissue connecting its margins. The so-called false diverticula always form on the concave side of the bowel, and are hernial protrusions, their walls being composed of peritoneum and mucous membrane.

* Amer. Journal Med. Sciences, July, 1884.

† Ueber Divertikel-Bildung im Darm-Kanale. Dissertation, Erlangen, 1854.

Greenhow* observed a case where a coil of the ileum had slipped through a slit in the mesentery of a diverticulum, which in this case contained omphalo-mesenteric vessels, and had become strangulated in this position. Sometimes a number of congenital diverticula are found in close proximity and at times associated with other congenital defects of the intestine.

Moore† exhibited to the Pathological Society of London the intestines of a man aged forty, showing three diverticula in the first three feet of the small intestine, and a congenital stricture at the commencement of the jejunum. The diverticula were each an inch long and about as much in diameter, and were on the mesenteric side of the intestine. Their walls consisted of all intestinal coats, and were not mere hernial protrusions. As long as the free end of a diverticulum remains unattached, strangulation from this cause cannot take place. Strangulation can only occur when both extremities are fixed, either as a congenital condition, or when later the free end becomes adherent to some fixed point. Harris‡ showed a specimen to the Pathological Society of Manchester of internal strangulation from a man, aged twenty. There was a whip-cord like adhesion about an inch and a half long, stretching from the tip of Meckel's diverticulum to the mesentery of the lower part of the ileum, and through the aperture so formed a loop of the lower part of the bowel had become strangulated. There had also been a twist of Meckel's diverticulum which had ruptured near its base, and death ensued from acute peritonitis consequent upon fæcal extravasation. That the danger of perforation and peritonitis from strangulation by a Meckel's diverticulum is greater than when the obstruction is caused by a ligamentous band, is shown by another case reported by Heiberg.§ The patient was a woman, forty years of age, who died in a few days from an acute attack of intestinal obstruction. At the necropsy he found a diverticulum seven inches in length thirty inches above the ileo-cæcal region, which constricted a loop of the ileum twenty-one inches in length. The free end of the diverticulum had passed between its base and the intestine, and was found here with its terminal end somewhat dilated. The softened wall of the diverticulum was found perforated at one point which had given rise to fæcal extravasation and septic peritonitis. A somewhat similar mechanism of strangulation by a diverticulum was described by Concato.‖ A man otherwise in perfect health was

* The Lancet, May 17, 1884.

† The Lancet, Nov. 10, 1883, p. 815.

‡ British Medical Journal, May 28, 1887.

§ Ueber innere Incarcerationen. Virchow's Archiv, B. LIV., p. 30.

‖ Virchow u. Hirsch's Jahresbericht, B. XI., 1871, p. 155.

attacked by acute intestinal obstruction and died on the fourth day. A loop of the small intestine was found constricted by a diverticulum located several feet above the ileo-cæcal valve, the free end of which had insinuated itself between the junction of the diverticulum with the intestine and constricted bowel, thus forming a firm knot around the bowel. That in most cases where a diverticulum causes an obstruction the free end has found a firm point of attachment is well shown by the cases tabulated by Cazin.* He collected thirty cases of intestinal obstruction caused by a diverticulum, and of this number in twenty-five the free end was found adherent. A diverticulum may give rise to symptoms of intestinal obstruction without directly interfering with the fæcal circulation. Such a case has been reported by Doran.† A boy, four years old, died on the fourth day after an attack of what resembled acute intestinal obstruction. At the necropsy a diverticulum the size of a pear was found at the junction of the ileum with the jejunum which contained a pea. The foreign body had caused ulcerative inflammation and perforation of the diverticulum and death from perforative peritonitis. The diverticulum was supplied with a mesentery and its walls were composed of all the tunics of the bowel.

Southey‡ alludes to another variety of obstruction caused by a diverticulum, viz: contraction of the intestine at a point where the diverticulum is given off. He gives a description of two such specimens. In one the diverticulum formed a band the size of a goose-quill and extended from a point two feet above the ileo-cæcal valve to the abdominal wall two inches below the umbilicus. The ileum just above the diverticulum was so constricted as only to admit the tip of the little finger, and at the point of constriction the coats of the intestine, both muscular and mucous, were ulcerated through, the continuity of the intestine being only preserved by the thickened peritoneum. In the second case the bowel, at a point about eighteen inches above the ileo-cæcal valve, was abruptly constricted to a diameter of about half an inch, and a diverticulum five inches long, having a calibre, large enough to admit the little finger, passed from the intestine and was attached at its extremity to the umbilicus. In this case death was hastened by acute diffuse peritonitis. That not all constricting bands are the remains of the vitelline duct requires no argu-

* Étude anatomique et pathologique sur les diverticules de l'intestin. Thèse. Paris, 1862.

† Case of Acute Intestinal obstruction; perforation of a diverticulum. Transactions of the Pathological Society, vol. xxiv, p. 122.

‡ Transactions of the Clinical Society of London, vol. v., 1872.

ment in speaking of the operative treatment of obstruction from constriction by bands, but the possibility of mistaking a peritoneal fold enclosing unobliterated umbilical vessels for an ordinary cicatricial band must be remembered and the necessary sections of the band made between ligatures. If Meckel's diverticulum is found to be the cause of obstruction this appendage should always be resected by ligating it at its base with a rubber ligature, and after the excision the end is invaginated and the invagination maintained by a few stitches of the continued suture. Weir recommends in the excision of a constricting diverticulum to apply a ligature and after cutting it off to stitch the peritoneal surface over the divided muscular and mucous coat, but when the diverticulum is nearly of the same diameter as the intestine from which it springs, such a course would not afford ample protection against perforation.

Clutton* related a case to the Clinical Society of London, of intestinal obstruction caused by a diverticulum successfully treated by operation. The patient was a boy aged 10 years, who had suffered on several occasions from colicky pains lasting for two or three days and always terminating with a copious evacuation from the bowels. This attack commenced with vomiting and great pain in the abdomen which persisted in spite of opium treatment for four days, when he was brought into the hospital and at once submitted to an operation. On opening the abdomen through the linea alba a collapsed portion of bowel was soon found, and, on bringing it to the surface, a tight ring-like cord could be felt and seen to be the cause of strangulation. The cord was divided between two pairs of forceps and each end tied with a catgut ligature. This step of the operation relieved the bowel from strangulation. On making an investigation as to the nature of the band divided, it was found that one of the ligatures was situated at the extreme end of a diverticulum two inches in length, and the other was placed upon the wall of the same loop of intestine at a distance of about six inches. A portion of the bowel about three inches in length between these two points of attachment was the part strangulated, and was of an extremely dark color with a deep sulcus at each side. The boy made an uninterrupted and rapid recovery.

Clutton explained the condition as follows : "The vitelline duct had become obliterated at the umbilicus, and set free from the abdominal wall, but remaining patent towards the ileum the lower end had become a pouch-like diverticulum from the intestine. This diverticulum terminating in a pointed extremity or cord part also of the vitelline duct which had been obliterated and remained floating about among the in-

* The Lancet, May 17, 1884.

testines till it became attached to the bowel in contact with it. The gut between the two points of attachment had slipped beneath the cord which united them, and being unable to extricate itself had become strangulated.

Another interesting case of intestinal strangulation caused by a Meckel's diverticulum and successfully treated by laparotomy is reported by McGill.* The patient was a man, aged 30 years, who had suffered from acute intestinal obstruction for nine days. The abdomen was very much distended at the time of operation. As the seat of obstruction could not be readily found by intra-abdominal palpation, partial extrusion of intestines was allowed to take place, but as soon as three feet of the small intestines had escaped the junction of the distended with the empty intestine came into view. At this point a Meckel's diverticulum much dilated and about six inches in length, was seen, passing downwards, and forwards, to be attached to the fundus of the bladder. A loop of collapsed intestine passed under the diverticulum, the obstruction being caused by the twisting of the bowel at the point where the diverticulum was attached. Slight traction proved efficient in releasing the bowel from the grasp of the diverticulum, and as soon as this was accomplished the empty portion of the bowel became filled with the intestinal contents. Nothing was done to the diverticulum. On the tenth day a small fæcal fistula formed at the lower angle of the wound. This continued two weeks when the discharge ceased and the patient recovered without any further untoward symptoms. The author believes that this is the first recorded case where the free end of the diverticulum had its attachment to the fundus of the bladder. There can be but little doubt that the fæcal fistula in this case was caused by a perforation of the diverticulum, an accident which might have proved fatal if extravasation had taken place into the peritoneal cavity, and which might have been avoided had the diverticulum been removed, which would also have protected the patient with certainty against a possible recurrence in the future of obstruction from the same cause.

6. *Non-malignant Stenosis.*

1. *Congenital.*—Congenital narrowing of the bowel varies in degree from a slight contraction to complete atresia. In my experiments on animals I have shown that when the lumen of the small intestines is diminished one-half in size by partial enterectomy and

*Remarks on a Case of Acute Intestinal Obstruction due to the Presence of a Meckel's Diverticulum Successfully treated by Laparotomy. British Medical Journal, January 14, 1888.

suturing of the wound in a direction parallel to the long axis of the bowel the function of the bowel is not impaired, and obstruction does not occur, but if the stenosis is carried beyond this point there is great danger of obstruction arising from accumulation of solid intestinal contents on the proximal side of the stenosis. The same holds true of congenital stenosis of the small intestines. Even if the narrowing is considerable no serious symptoms are produced until some foreign bodies collect above the seat of constriction and cause obstruction from coprostasis.

Legg* reports an exceedingly interesting case where a congential stenosis of the ileo-cæcal opening led to chronic obstruction, dilatation of ileum, and finally to perforation into the ascending colon. A female 26 years of age was admitted into the hospital April, 1858. She stated that since she was five years of age she suffered from occasional attacks of colic, perhaps five times during a year, attended by constipation and vomiting. After such an attack eight years ago a number of cherry stones passed with the fæces. Recently the attacks became more frequent, and the last was so severe that she found it necessary to seek admission into the hospital. When admitted she presented many symptoms of obstruction. In the right iliac fossa on percussion a dry crackling sound could be heard and felt. In a few days she again passed a few cherry and plum stones and felt relieved. She was given five gutta percha pills which never passed through. She left the hospital improved and was not seen again until six years later. At this time she again suffered from well-marked symptoms of intestinal obstruction, and during the first few days vomited a number of cherry and plum stones, and a black round mass which on cutting was believed to be one of the gutta percha pills which she had taken six years before. Below the umbilicus the same crackling sound could be heard and felt as before. The symptoms of obstruction gradually became worse and a few weeks after admission she died. At the necropsy the entire colon was found empty and contracted, the ileum very much dilated, so much so that the lower portion measured seven inches in circumference. On opening it fluid fæces and a few fruit stones escaped. Ileo-cæcal orifice contracted so that it would admit only a number nine catheter. Above the ileo-cæcal valve a communicating bimucous fistulous opening the size of a quarter of a dollar had formed between the colon and ileum, and a little above this point another but smaller opening had formed in the same manner by

* Congenital Constriction of the Ileo-cæcal Orifice and Dilatation of the Ileum; Retention of Fruit-stones in Jejunum and Ileum. Trans. Pathological Society, vol. xxi., p. 171.

adhesion and perforation. In the small intestines a pint of cherry stones were found, all of them covered with a black crust which on examination proved to contain iron. The author could find in literature only six cases of non-malignant stenosis of the ileo-cæcal opening. In Schrœder van der Kolk's case the opening was even smaller and in the lower portion of the ileum which was enormously dilated a large mass of cherry stones and fragments of bone were found.

Bourdon* observed another case of congenital stenosis of the ileo-cæcal orifice as narrated by Dor.† The patient was a man, 32 years of age, who had suffered for a month from pain in the abdomen, nausea and vomiting. The bowels were moved with difficulty by cathartics. On examination nothing could be found except a doughy condition of the middle portion of the abdomen where percussion revealed also a certain degree of dullness. He remained two weeks in the hospital without any improvement being noticeable, when he left, but returned two days later. At this time an irregular uneven swelling could be distinctly felt in the right groin. The swelling rapidly increased in size and the patient died in a few days of peritonitis. At the necropsy the small intestines were found very much distended, colon and rectum contracted and empty. Just above the ileo-cæcal valve the ileum was distended to the size of a fœtal head adherent to the posterior abdominal wall, mesentery and intestinal coils. The walls of this pouch were thickened and of a brown color. When opened it was found to contain 120 plum-stones and 92 lead bullets. The ileo-cæcal valve was nearly closed and was permeable only to fluids. The patient had probably swallowed the bullets to overcome obstinate constipation. In all of these cases of congenital stenosis no symptoms were caused by the congenital effect until the foreign bodies which collected above it finally produced death from intestinal obstruction or perforative peritonitis. The clinical history in each case distinctly points to aggravation of the obstruction by the occurrence of coprostasis above the seat of stenosis. The surgical treatment in such cases consists in removing the impacted substances through an incision above the stenosis, and after clearing the bowel of its contents unite it with a similar incision in the bowel below the obstruction by lateral apposition with decalcified perforated bone plates, thus establishing a free anastomosis between the bowel above and below the obstruction, and excluding at the same time permanently from the intestinal circulation the contracted portion of the intestine. Excision and restoration of the continuity of the intestinal canal by circular enterorrhaphy can only be thought of in case perforation has taken place.

* L'Union 57, 1856. Schmidt's Jahrbücher, B. XCVI, p. 204.

† Gaz. Med. de Paris, 1835, No. 9.

2. *Acquired or Cicatricial.*—Cicatricial stenosis of the intestines is one of the remote consequences of deep ulcerative lesions such as are caused by dysentery, typhlitis stercoralis, tuberculosis, and ileo-typhus. The cicatrix which forms during the reparative stage of the ulceration contracts slowly and gives rise to stenosis and chronic intestinal obstruction. As in cases of congenital stenosis the obstruction often becomes complete and gives rise to acute symptoms when foreign bodies or solid fæces become impacted above the seat of constriction. Not infrequently the causes which have led to cicatricial stenosis are located at the same time or appear successively in different parts of the intestine, producing consequently also multiple strictures.

Sharkey* presented to the Pathological Society of London a specimen of multiple strictures of the ileum taken from a woman 33 years of age, who had suffered frequently from indigestion and vomiting. The immediate cause of death was facial erysipelas. The lower two-thirds of the small intestines exhibited numerous ulcers apparently healed. They were so near together and produced such marked constriction that the appearance of a succession of pouches was simulated. There were no distinct evidences of tuberculosis in the intestine or any of the other organs. In the discussion which followed the demonstration of this specimen Treves spoke of other somewhat similar recorded cases in which typhoid fever and tuberculosis seemed to be excluded. Treves† has described another cause of cicatricial stenosis. He has met with such cases in patients who suffered from a strangulated hernia when the prolonged compression during the strangulation had produced a circumscribed gangrene of the mucous coat. In all of the recorded cases the patients appear to have recovered well from the hernia trouble, and after a varying time to have gradually developed symptoms of cicatricial stenosis of the small intestines.

Another form of cicatricial stenosis of the intestines is caused by the formation of a cicatrix in the peritoneal coat as the result of a circumscribed plastic peritonitis. In this form the mucous and muscular coats are intact, but the bowel is narrowed and puckered by a band of cicatricial tissue. Cicatricial stenosis of the colon is caused most frequently by dysentery, while the same condition in the rectum often appears as a syphilitic lesion. In the treatment of cicatricial stricture of the intestine the question of resection again confronts us. Maydl‡ reports two successful cases of circular resection and suturing for cicatricial stricture of the ileo-cæcal valve. In the first case he relieved

* The Lancet, May 24, 1884.

† Intestinal Obstruction that may follow after Hernia. The Lancet, June 7, 1884.

‡ Ueber einen zweiten Fall von narbiger Striktur der Ileo-cæcal Klappe durch cirkuläre Darmresektion und Naht geheilt. Allgem. Wiener Med. Zeitung, 1881, No. 17.

the obstruction by an enterotomy and a year later excised the constricted portion of the cæcum and united the ileum with the ascending colon. In the second case the general condition of the patient warranted a radical operation, which consisted in the excision of the cæcum and immediate restoration of the continuity of the intestinal canal by suturing. The condition in these cases for circular enterorrhaphy were unusually favorable as the colon must have been in a contracted state, while the lower portion of the ileum from the prolonged obstruction was much dilated so that the lumina of the resected ends must have been nearly equal in size. Both patients recovered. In the first case where the patient suffered all the inconveniences of an artificial anus for one year, a radical operation by an ileo-colostomy could have been made with no more risk than was incident to the enterotomy, and would have thus avoided the necessity of establishing an artificial anus and of performing a second operation. Where no gangrene or perforation is present, I should strongly recommend the substitution of intestinal anastomosis for resection and circular enterorrhaphy. In cases of multiple stricture where they involve a limited area of the intestine an anastomosis should be made between the intestines at a point above the first and below the last stricture excluding permanently the intervening portion from the fæcal circulation.

Eddowes* operated on a case of intestinal obstruction due to a cicatricial stricture where the symptoms were promptly relieved by the formation of an artificial anus, and the patient recovered with a permanent fistula. A woman 46 years old was seized nineteen days before the operation with abdominal pain which had persisted ever since. For twelve days there had been no action of the bowels without enemata ; complete constipation had existed for five days. There was no history of syphilis, tuberculosis or cancer. The abdomen was distended, but soft and free from tenderness ; the walls were very thin, and moving coils of small intestine were plainly seen. The abdomen was opened by an incision four inches long in the median line between umbilicus and pubes. A small quantity of peritoneal fluid mixed with lymph escaped, and the abdominal contents appeared congested. A stricture of the small intestine was soon found, forming a complete obstruction, impermeable even to flatus. An artificial anus was formed at the lower extremity of the wound about two inches from the pubes. The operation was followed by a great sense of relief. The lower portion of the wound suppurated on account of escape of fæces, otherwise the recovery progressed favorably. Seven months after the operation the patient was in perfect health, had

* The British Medical Journal, July 24, 1886.

gained considerably in weight, and was able to go about her household work as before. The bowels acted very regularly every morning, the motion was gradually formed, and in this case she had very good control, but she was unable to control liquid motions and flatus. On introducing the finger, it was felt to be distinctly grasped by a sphincter. Although the symptoms of obstruction were successfully removed by establishing an artificial anus in the median line, the course of practice is open to serious objections. An artificial anus should never be established in the median incision, as the contact of fæces with the wound necessarily prevents healing by first intention. If such a course is contemplated after the abdomen has been explored through a median incision, a small incision for the enterotomy should be made in one of the inguinal regions and the median incision closed and dressed separately. In following such a course the large incision will heal by primary union and the abdomen can subsequently be opened again to better advantage through the median line for the performance of a radical operation. This, like all similar cases, would have been a proper subject for intestinal anastomosis.

In non-malignant stricture of the colon colectomy and circular enterorrahaphy should be done in all cases where approximation of the bowel ends is possible. In multiple strictures of this portion of the intestinal canal resection is inapplicable, and the obstruction can only be rendered harmless and the continuity of the intestinal canal restored by lateral implantation or by establishing an intestinal anastomosis.

Coupland and Morris* have collected a number of cases of stricture of the intestine, and in commenting on the material assert that in three-fourths of all cases the disease affected the lower part of the bowel, being about equally divided between the rectum and the sigmoid flexure. With few exceptions strictures are located below the cæcum. In many of the fatal cases death occurred from perforation either above the stricture or in the cæcum. From Bryant's investigations it appears that one-third of the cases of stricture of the rectum or lower bowel are not malignant, a most important practical point with regard to treatment. He lays down the following general rule for performing lumbar colotomy in cases of stricture of the rectum: "In all cases of cancerous stricture of the rectum or colon, including the annular which are not amenable to lumbar colectomy or anal excision, right or left lumbar colotomy is strongly to be advocated, with the well-grounded hope of relieving suffering, retarding the progress

* On Strictures of the Intestine; with Remarks upon Statistics as a guide to Diagnosis and Treatment, 1878.

of the disease, and prolonging life even for five or six years. To secure these advantages it is necessary for the operation to be performed before the pernicious effects of obstruction occur."

Against lumbar colotomy I have already in another part of the paper entered my protest, and in cases of inoperable carcinoma of the rectum producing evidences of obstruction, I wish to call attention to the method of operating devised by Madelung.* In cases of malignant stricture of the rectum, where it is desirable to exclude the part at and below the seat of obstruction completely and permanently from the fæcal circulation, he opens the abdomen by a lateral incision and divides the colon completely in a transverse direction and as low down as possible. The distal end is closed by invagination and two rows of sutures, and dropped into the peritoneal cavity, while the proximal end is sutured into the wound. This operation secures absolute physiological rest for the diseased portion of the bowel and is less likely to be followed by prolapse, as is the case when the bowel is simply stitched into the wound and opened. Anal extirpation of the rectum, both for cicatricial and carcinomatous stenosis, should always be practised when the obstruction and the local conditions which have caused it can be removed by this method.

7. *Tumors.*

A tumor can give rise to intestinal obstruction in different ways according to its location and anatomico-pathological character. A tumor or swelling outside of the intestinal tube may cause obstruction by compression. A polypoid growth springing from the mucous or submucous tissue interrupts the fæcal circulation either by blocking the lumen of the bowel by its size, or by causing an invagination or flexion. A circular carcinoma produces a stenosis which leads to chronic obstruction, but which is frequently the indirect cause of acute intestinal obstruction when either by additional pathological changes at the seat of the malignant disease or by the accumulation of foreign bodies or solid fæcal masses above the seat of constriction the fæcal circulation is completely arrested.

1. *Non-malignant Tumors.*—Benign polypoid tumors seldom attain a sufficient size to give rise to intestinal obstruction, unless they cause additional mechanical disturbance such as invagination or flexion, conditions which have already been alluded to. If the tumor alone is the cause of obstruction it is removed by laparo-enterotomy. A few cases have recently been reported where the obstruction was caused

* Modification der Colotomie wegen Carcinoma Recti. Verh. der Deutschen Gesellschaft f. Chirurgie, 1884.

by cysts. In Buchwald's case* the symptoms of obstruction were acute and laparotomy was performed on the third day. The patient was a boy who had previously been in good health. As soon as the peritoneal cavity was opened two cysts attached to the small intestine presented themselves in the wound. As the cysts had produced a sharp flexion 9 ctm. of the bowel including the cysts were resected and the ends united by circular suturing. Twenty-seven hours after the operation the patient died. The necropsy showed that the resected piece was taken from the jejunum one-half metre below the duodenum. One cyst measured 17 and the other 10 ctm. in diameter. The walls of the cyst were white and very thin. The microscopical examination showed that they were composed of the same tunics as the bowel, but the mucous membrane was atrophied and contained no glands. The cysts communicated with each other and the lumen of the bowel. The latter was not diminished in size. The cysts contained a yellowish fluid with a strong odor of aceton. Under the microscope the contents showed cylindrical cells in a state of fatty degeneration, cholesterine crystals, granules of leucin, fat globules, and rod-shaped bacteria, but no intestinal contents. He believes that the cysts had no connection whatever with the vitelline duct.

Kulenkampff † reports the case of a child 3 years old, that had suffered occasionally from colic and constipation, and was attacked suddenly with symptoms indicative of acute intestinal obstruction. Abdomen somewhat tympanitic, but no swelling could be made out by percussion and palpation. Tenderness and slight dulness in the right inguinal region. The boy died on the second day. The autopsy revealed as the cause of death a cyst in the region of the cæcum. The cyst was as large as a man's fist and had thin almost transparent walls. It showed several depressions which gave it the appearance of being composed of three or four parts. It was located in the mesentery of the ileum about 40 ctm. above the ileo-cæcal valve. It did not communicate with the lumen of the bowel and contained a thin chocolate-colored fluid. The mesentery at this point was drawn out like a string and encircled a loop of the ileum. Above this point the bowel was greatly distended. He believed with Roth‡ that the cyst was congenital and had developed from a diverticulum of the ileum. As a rule such cysts are located on the convex side of the bowel, but in this instance it occupied a position opposite.

* Ueber Darmcysten als Ursache eines kompleten Darmverschlusses. Deutsche Med. Wochenschrift, 1887, No. 40.

† Ein Fall von Entero-kystom. Tod durch Darmverschlingung. Centralblatt f. die gesammte Medicin, 1883. No. 42.

‡ Virchow's Archiv, B. LXXXVI, p. 311.

At first sight the cyst appeared like a greatly distended loop of the intestine. As in both of these cases the cyst had produced intestinal obstruction by secondary mechanical conditions, the operative treatment of the obstruction would include the removol of the primary cause and the correction of the secondary mechanical difficulties. This would include resection of the bowel at the seat of obstruction including the tumor and restoration of the continuity of the intestinal canal by circular suturing.

2. *Malignant Tumors.*—Malignant stenosis of the intestines may be caused either by a sarcoma or carcinoma, of which the former is more frequent above and the latter below the ileo-cæcal valve. A sarcoma in the intestine like in any other organ primarily starts from an embryonal matrix of connective tissue and hence it always has its starting-point in the wall beneath the mucous membrane, while carcinona being an atypical proliferation of epithelial cells either commences in the mucous membrane or its glandular appendages.

a. Sarcoma.—Nicolaysen* reports an exceedingly interesting case of enterotomy for a sarcomatous stenosis of the small intestine. The patient was 28 years of age. A firm nodulated kidney-shaped tumor could be felt in the abdomen below the umbilicus. The tumor was first noticed six months before when it was as large as a hen's egg. In the morning the tumor usually could be felt under the costal arch, while during the day it descended into the hypogastric region where it always caused more pain. As the symptoms of obstruction gradually increased in severity and did not yield to ordinary treatment laparotomy was performed. Median incision 14 ctm. long. It was found somewhat difficult to bring the tumor forward into the wound. The tumor occupied the mesenteric side of the bowel and behind it a number of enlarged lymphatic glands could be felt. Eighteen ctm. of intestine including the tumor and a triangular piece of mesentery were excised and the ends of the intestine united with sutures, embracing only serous and muscular coats, whereupon the proximal end was invaginated to the extent of 2 ctm. and the invagination retained with five Lembert sutures over which the peritoneum was once more stitched with a continued suture of fine catgut. The mesenteric wound was also closed by suturing. The tumor consisted of several nodules the size of a goose egg which had perforated the intestine. Microscopical examination of the tumor and lymphatic glands showed sarcomatous tissue. The patient recovered.

* Myosarkom des Dünndarmes. Extirpation mit Darmresektion. Centralblatt f. die ges. Medicin, 1886, No. 28.

Bessel-Hagen* described a somewhat similar specimen which he found in a child. A boy seven years old after a trauma suffered from a rapidly growing tumor in the abdomen which resulted in death from marasmus in four months. At the autopsy a large sarcoma of the jejunum was found which had perforated into the gut by necrotic destruction of the interior of the tumor. Microscopic examination proved it to be a small-celled, round-celled sarcoma which had originated in the submucosa of the jejunum. Multiple metastasis in kidneys, on back and in the lymphatic glands. Peritonitic adhesions had caused flexion of the intestine below the tumor and dilatation of the proximal portion from obstruction thus produced. As a sarcoma of the intestine only gives rise to symptoms of obstruction and consequently comes under surgical treatment usually after extensive infiltration of the mesentery and retro-peritoneal tissues has taken place, it is questionable if it is prudent to attempt a radical operation, as in case the patient recovers from the operation an early recurrence is almost inevitable. If a sufficiently early diagnosis were possible resection could be made with a fair prospect of a permanent result, but if the infection has extended to the tissues around the bowel it is more judicious to leave the sarcoma and to exclude the obstruction by an intestinal anastomosis.

b. Carcinoma.—In most cases of carcinoma of the intestine the disease commences in the mucous membrane, in which case the parenchyma of the tumor is composed of cells which resemble the columnar epithelium which lines the intestinal canal. Carcinoma is found most frequently in the region of the sigmoid flexure, the cæcum and rectum. A malignant stenosis may have existed for months without symptoms, when of a sudden symptoms of acute intestinal obstruction are developed as in the case related in this paper. In cases of acute intestinal obstruction in elderly people where no cause for it can be found in the abdomen a thorough rectal examination should never be neglected. During my visit in Zurich last year I was present at a very interesting autopsy made by Klebs upon one of Krönlein's patients. A few days before a woman 40 years of age was brought into the hospital presenting well-marked symptoms of intestinal obstruction, which had lasted for two weeks. On examination no cause for the obstruction could be found. The abdomen was very tympanitic rendering palpation difficult and unsatisfactory. Laparotomy was made, but as nothing could be found and the small intestines were enormously distended throughout, inguinal colotomy was performed. The operation was followed by decided relief, the abdomen collapsed and a large quan-

* Ulceröses Sarcom des Jejunum bei einen Kinde. Virchow's Achiv, B. XCIX., Heft 1.

tity of fæces was discharged through the artificial anus; but the patient died of exhaustion the next day. At the post-mortem examination the cause of the obstruction was found 20 ctm. below the artificial anus in the shape of a narrow annular carcinomatous stricture of the colon. In his remarks on the case Krönlein stated that he had observed four similar cases during the time he had been in Zurich. It is not unusual that such a stricture gives rise to no symptoms until suddenly symptoms of complete intestinal occlusion are developed. It would be well in the future, when a similar condition is suspected, to explore if need be the upper portion of the rectum and lower extremity of the colon as far as accessible by Simon's method, as in case the lesion is recognized and accurately located some of these cases might be amenable for a radical operation by incision. Schede* made a resection of the small intestine for carcinoma in a case where the tumor had extended to the abdominal wall. The intestine was excised with the tumor and the ends united by circular suturing. The patient recovered. A few weeks later he returned to the hospital with symptoms of complete intestinal obstruction. The abdomen was again opened and an artificial anus was established. The patient died on the fifth day. The cause of obstruction was a constricting band which was divided during the operation. Schede is of the opinion that in cases of complete obstruction of the bowels by a malignant tumor, excision is contra-indicated as in nineteen cases of intestinal resection for malignant disease, of six cases in which the occlusion was complete all died, while of the remaining twelve where the occlusion was only partial only three died. These statistics should only induce us to endeavor to make a correct diagnosis before urgent symptoms have set in and to resort to operative treatment at a time when the general condition of the patient is such as to warrant a radical operation and the local conditions at the seat of obstruction are favorable to a speedy process of repair. If, after resection of the lower portion of the colon it is found impossible to approximate the two ends of the bowel and the distal end is not sufficiently accessible to make an intestinal anastomosis or lateral implantation, then the course adopted by Gussenbauer† in one of these cases should be chosen. This patient was a man, 46 years of age, who had suffered for years from obstinate constipation. On examination he discovered a tumor the size of a hen's egg in the left hypogastric region, two-fingers breadth below a line drawn from an anterior superior spinous process of the ileum to the other. The tumor

* Verh. der Deutschen Gesellschaft fuer Chirurgie, 1884.

† Zur operativen Behandlung der Carcinome des S. Romanum. Prager Zeitschrift f. Heilkunde, 1881.

could also be felt high up in the rectum by pressing it downwards into the pelvis. The abdomen was opened by an incision over the tumor parallel with the course of the descending colon. The tumor was found to occupy the most prominent portion of the sigmoid flexure, freely movable, and not attached to any of the surrounding organs. A few glands behind the affected portion of the colon were enlarged. Circular resection was made including a corresponding portion of the meso-colon and the enlarged lymphatic glands. On account of too great loss of substance circular enterorrhaphy could not be made, consequently the distal end was closed by invagination and suturing and dropped into the abdominal cavity, while the proximal end was sutured into the external wound. The patient made a good recovery, and at the end of ten months the disease had not returned. Bull* reports two cases of carcinoma of the sigmoid flexure where in each instance he opened the abdomen through the median line and stitched the descending colon into the wound without incising it, reserving this step of the operation until adhesions had taken place. Both patients recovered. In one of these cases he resected six inches of the colon including the artificial anus and the tumor twelve months later, and the patient again recovered from the operation. At the time the report was made the operator had in view a third operation for the closure of the second artificial anus which was made at the close of the second operation. In all cases where the seat of obstruction can be located in the cæcum or colon before the operation the lateral incision should be selected, as it will afford better access to the seat of obstruction than a median incision. If it is found impossible to remove the obstruction, one of two things must be done. If the bowel below the obstruction can be reached an intestinal anastomosis is made, or the ileum is divided just above the ileo-cæcal valve, the distal end closed, and the proximal implanted into the bowel below the seat of obstruction. If resection can be done with a prospect of removing all the diseased tissues it should be invariably practised, as a primary radical operation, and if on account of its extent circular enterorrhaphy cannot be done, the distal end is permanently closed, and the proximal stitched into the wound. If the distal portion can be reached the continuity of the intestinal canal is restored by intestinal anastomis or lateral implantation. If the seat of obstruction cannot be ascertained before the operation and exploration through a median incision locates it in the cæcum, colon, or rectum, it may become necessary to make a lateral incision if a radical operation is decided upon, and when this appears impossible or unjustifiable an intestinal anastomosis or lateral implant-

* Gaillard's Medical Journal, March, 1888.

ation can be made through the median incision, and if on account of the location of the obstruction either of these operations are also inapplicable, an artificial anus should be established in the right or left inguinal region, and the median incision closed and dressed separately.

V. Dynamic Intestinal Obstruction Caused by Suspension of Peristalsis.

A number of pathological conditions are known to produce symptoms which so closely resemble intestinal obstruction that the abdomen has been repeatedly opened in such cases with the expectation of removing the cause of the obstruction, but no occlusion of any kind could be found. These are the cases that have caused the greatest difficulty in diagnosis, and have often brought disappointment and reproach upon the surgeon. The obstruction in these cases is not caused by a narrowing of the lumen of the intestine, but by suspension of the dynamic forces which propel the intestinal contents, and which result in accumulation of the fæces and gases in the paralyzed portion of the bowel, which is followed by distension of the intestines, constipation and obstinate vomiting which in rare cases may become fæcal. Circumscribed or diffuse paresis of the intestines is caused either by an inflammatory affection, such as peritonitis or enteritis, which produces suspension of muscular contractions in the same manner as when an inflammatory process in any other organ affects directly the muscular tissue, or the tunics of the intestines are in an intact condition, but a paralysis has resulted from reflex causes. Pitts* narrates two cases in which after reduction of a strangulated hernia he performed laparotomy on account of persisting symptoms, and found no cause for these symptoms save that presented by the free but lifeless coil that had been liberated too late.

The contents in a paretic bowel are liable to undergo fermentative and putrefactive changes and the gases which are developed during such changes accumulate and cause such an extensive tympanites that the latter may become a mechanical cause of obstruction.

1. *Tympanites.*—Cases of sudden death from obstruction of the intestines and stomach by rapid accumulation of gas have been reported by Dechambre, Mercier, L'Pereyra, and others. The patients were generally aged persons, or young persons during convalescence from protracted diseases.

Guéneau de Mussy† in a clinical lecture treats of the mechanical

* St. Thomas' Hospital Reports. Vol. xi., 1882, p. 75.

† Des conditions Mechaniques de la tympanite. Gaz. hebd., 1867, No. 31.

conditions which cause accumulation of gas in the intestines. Where no mechanical obstruction is present the gaseous distension is due to paralysis of the sympathetic nerves. The failure of the gas to be expelled is owing to the formation of numerous flexions from the overdistension and later to compression of some parts of the intestines by the distended loops. The lowest portion of the ileum may be compressed against the ascending colon so firmly as to become a cause of complete mechanical obstruction. Proof of the existence of such a mechanical condition is furnished in cases of extensive tympanites where the introduction of a rectal tube affords no relief. In such cases the distension increases even after death. The author has also furnished experimental proof. The cadaver of a child was inflated moderately through the œsophagus, after which the œsophagus was tied and a tube was introduced into the rectum and its distal end immersed under water. Pressure upon the abdomen expelled the air through the rectal tube. When he repeated the experiment, but carried the distension farther, no air could be made to escape through the rectal tube by compressing the abdomen. On opening the abdomen with great care, it was seen that the lower portion of the distended ileum was pressed against the ascending colon so firmly as to completely interrupt the communication between them. From these observations it can be readily seen how the formation of an intestinal anastomosis would frequently prove the means not only in relieving the obstruction, but also in the removal of its cause.

If gas is present in the peritoneal cavity as the result of putrefactive changes of the products of peritoneal inflammation, it presses the liver away from the diaphragm and the percussion dullness disappears completely when the patient lies on his back. In distension of the abdomen from the presence of gas in the intestines the diaphragm and liver are crowded upwards, but the latter remains in contact with the chest wall, and the area of liver dullness remains the same, but is displaced in an upward direction. Where life is threatened by tympanitic distensions of the abdomen during the convalescence from acute diseases the symptoms appear very rapidly and death results from mechanical compression of important organs. Puncture of the distended intestines followed by aspiration and if need be repeated at short intervals is positively indicated in most cases. There can be no doubt that in many cases of peritonitis attended by diffuse and excessive tympanites the symptoms which point to intestinal obstruction are due to the same causes, flexions and compression, and such cases would also be greatly benefitted and sometimes cured by the same treatment.

2. *Peritonitis.*—Peritonitis may lead to symptom resembling intestinal occlusion in different ways according to the extent and type of the disease. In extensive plastic peritonitis the immobilization of a considerable portion of the small intestines may give rise to persistent vomiting, and absolute constipation. Again, as we have just seen arrest of the fæcal circulation may be caused by the tympanites alone, while perforative peritonitis is attended by a local and general shock which causes intestinal paresis through the sympathetic nerves. Heusner* has observed that perforative peritonitis gives rise to disturbances simulating intestinal obstruction by arresting intestinal movements. He narrates the history of two cases of this kind where the symptoms of intestinal obstruction were so prominent that laparotomy was performed. In both cases, perforative peritonitis, but no occlusion, was found.

Henrot,† in his classical monograph on pseudo-strangulation describes a number of cases of perforation of the gall-bladder and the processus vermiformis where the symptoms during life had pointed so strongly to the existence of intestinal obstruction that a wrong diagnosis was made by able clinicians. He also calls attention to those cases of paralytic obstruction which are often observed after herniotomy and in cases of strangulation of the appendix vermiformis and testicle. The intestinal paresis, where it is not the result of inflammation must be looked upon as a reflex symptom.

Physical signs and symptoms are sometimes utterly inadequate to enable a distinction between acute intestinal obstruction and diffuse peritonitis. In differentiating between these two conditions it must be remembered that in the absence of a tumor absolute constipation and fæcal vomiting are the most characteristic symptoms of obstruction and that in peritontis the pain is severe and continuous, with diffuse tenderness, tympanites, and absence of visible intestinal coils. In mechanical obstruction of the bowels the temperature as a rule is not above normal unless complications have set in, while in peritonitis a rise in temperature is the rule although in some of the gravest cases it is subnormal. Many cases of supposed recovery of intestinal obstruction without operation undoubtedly were cases of dynamic obstruction, and the recovery was either entirely spontaneous or facilitated by means which assisted in the restoration of the peristaltic action. In 1851 a patient was admitted into Dupuytren's ward with well-marked symptoms of acute intestinal obstruction. This eminent surgeon gave it as his opinion that without an operation a fatal ter-

* Deutsche Med. Wochenschrift, 1877.

† Des Pseudo-etranglement, etc., Thése, Paris, 1865.

mination was inevitable, but the patient objected to the operation and was transferred to another ward, where he recovered in three days under the use of simple cathartics.

Numerons similar cases could be cited in illustration of the difficulty of differentiating in all cases between mechanical occlusion and dynamic obstruction.

3. *Catarrhal and Ulcerative Enteritis.*—For some reasons which at present it is difficult to explain, simple catarrhal enteritis and circumscribed ulcerations of the small intestines have occasionally been the cause of rapid accumulations of gas followed by symptoms of intestinal obstruction. Mercier* has recorded a case where a patient died after a brief illness during which all symptoms pointed to the existence of intestinal obstruction, including complete constipation and fæcal vomiting. The necropsy showed no stenosis or any other form of mechanical obstruction, but several large ulcers in the middle of the ileum.

Mosler† reports a case of acute intestinal obstruction which followed a catarrhal enteritis, where on post-mortem no primary mechanical obstruction could be found. The small intestines were so enormously distended that they filled the entire abdominal cavity, compressing the ascending colon so firmly as to render it completely impermeable; the transverse colon was also compressed, but to a lesser extent.

Zimmermann‡ described a case of acute intestinal obstruction, where during life the collapse came on so rapidly as to resemble cholera. The bowels remained completely constipated, and the vomiting was so severe and persistent that on the seventh day it became stercoraceous. The patient lived six weeks. At the necropsy the small intestines were found enormously distended and their walls were much attenuated. Colon was also distended. In the ileum a number of small ulcers were found which had destroyed the entire thickness of the mucous membrane. In a case of this kind, Obalinsky made a laparotomy and as he found the external surface of the lower portion of the ileum only congested, but no mechanical obstruction, he closed the external incision and the patient recovered. He believed that in this case there were typhoid ulcers which caused a functional stricture of the gut and the symptoms which induced him to open the abdomen.

* Note sur deux cas d'ileus. Gazette Méd. de Paris, 1867, p. 151.

† Ueber den Ileus. Archiv der Heilkunde, 1864, No. 2.

‡ Ein Beitrag zur Lehre vom dynamischen Ileus. Canstatt's Jahresbericht, 1860, B. III., p. 245.

4. *Exventration.*—At a recent meeting of the Berlin Obstetrical Society, Olshausen reported several cases of laparotomy, in which more or less exventration became unavoidable during the operation. A few days after the operation the patients presented all the appearances of an attack of acute intestinal obstruction and death followed five to ten days after the operation. Olshausen explained the symptoms during life, and the fatal termination by assuming the existence of intestinal paralysis, distension of the bowel and absorption of toxic agents from the intestinal canal. During the exventration the intestines became engorged by venous hyperæmia, which in turn again is followed by exudation into the tissues of the bowel.

Sebileau * re-opened the abdomen in two cases of acute intestinal obstruction after laparotomy, and no mechanical occlusion or exudation of any kind, but enormous meteorism was found. He attributes this condition to intestinal paresis and rapid accumulation of gas. The prophylactic treatment of such cases is more important than the curative. The administration of a brisk cathartic on the second or third day after the operation will usually prevent tympanitic distension of the abdomen by stimulating the paretic walls to active muscular contractions, and by removing the intestinal contents the source of putrefactive changes. This treatment should never be postponed until the paralysis has been aggravated by over-distension, but should be resorted to either before or upon the first appearance of intestinal distension. Uniform compression of the abdomen with strips of adhesive plaster and bandage applied over the antiseptic absorbent dressing immediately after the operation should be kept up until all danger from the occurrence of tympanites has passed. When the distension has become so great as to threaten life, the treatment should consist of the employment of such prompt mechanical measures which will diminish the intra-abdominal pressure. As the stomach may also be dilated its contents should be removed through a flexible stomach tube, followed by an irrigation with a harmless antiseptic solution. Tubage of the colon followed by a turpentine enema is used for the same purpose. If these measures fail in relieving the distension a prompt resort to intestinal puncture with a fine hollow needle becomes imperative. This surgical resource may be repeated as often as it may become necessary to avert danger from an increasing intra-abdominal pressure.

* De quelques accidents intestinaux survenant aprex les opérations abdominales. Annal. de Gynécologie, T. xxv., p. 118).

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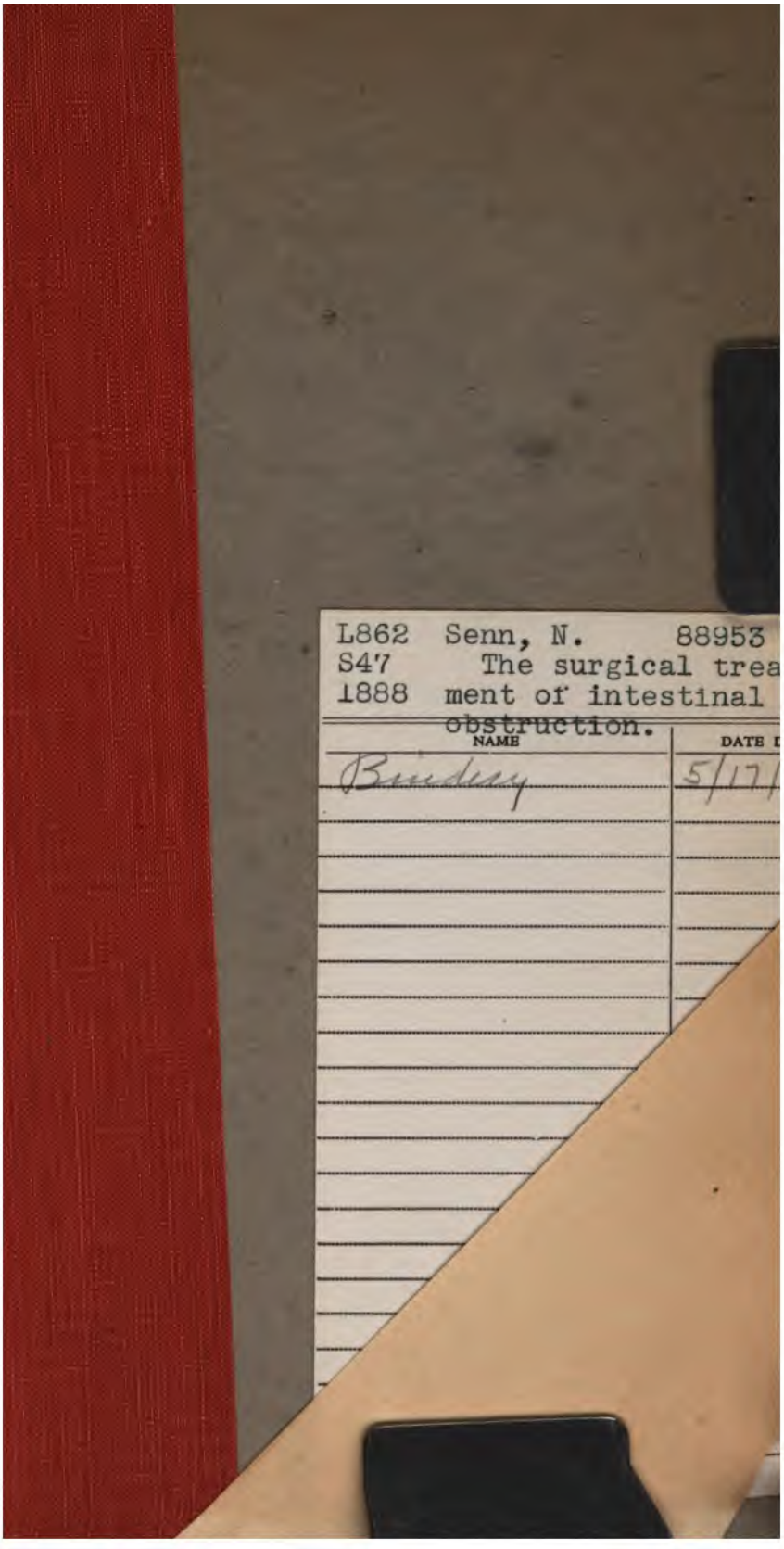
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